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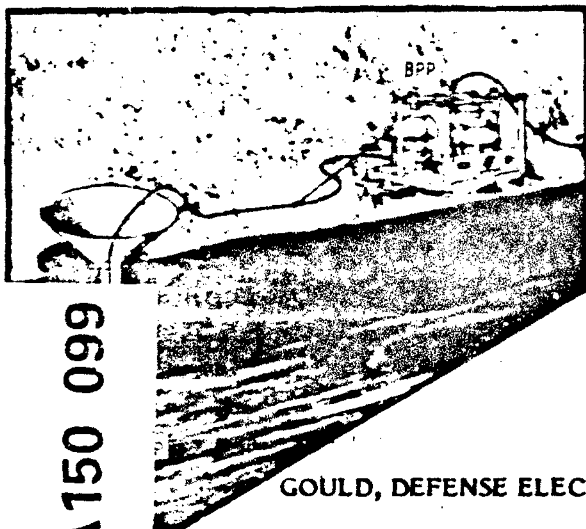

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GOULD, DEFENSE ELECTRONICS DIVISION

MARINE SEISMIC SYSTEM (MSS)

DEVELOPMENT, DEPLOYMENT AND RECOVERY

FINAL REPORT

UNCLASSIFIED/UNLIMITED DISTRIBUTION

SPONSORED BY:

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
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NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY (NORDA)
National Space Technology Laboratories, Mississippi 39529

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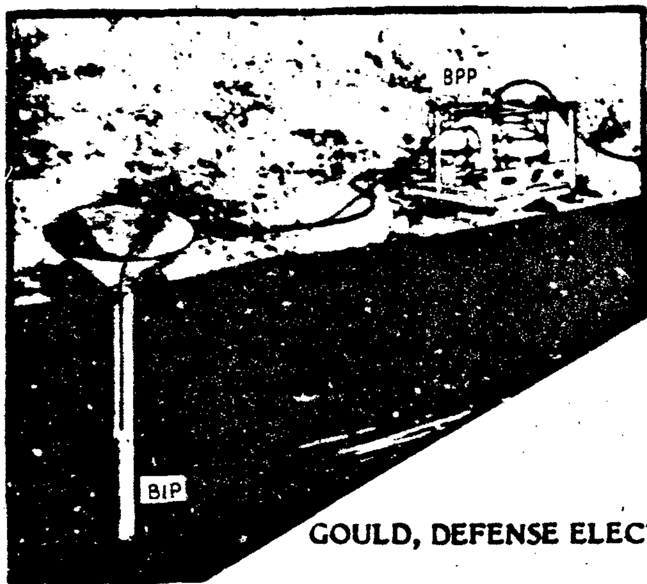

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"The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Defense Advanced Research Projects Agency, the Naval Ocean Research and Development Activity, or the U.S. Government."

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TABLE OF CONTENTS

Section	Title	Page
1.0	Summary	1
	1.1 Introduction	1
	1.2 Background - System Study and Specification	1
	1.3 System Design, Development and Deployment	2
	1.4 Accomplishments and Lessons Learned	8
2.0	MSS System Definition	14
	2.1 MSS Subsystem Configurations and Modes of Operation	14
	2.2 BIP Data Transceiver Unit (DTU) Function Requirements	17
	2.3 Bottom Processing Package (BPP) Functional Requirements	23
3.0	Gould Equipment System Description	27
	3.1 BIP Configured Equipment	27
	3.1.1 Data Transceiver Unit (DTU) Component	27
	3.1.2 FM/FSK Telemetry Communication Link	30
	3.2 BPP Configured Equipment	33
	3.2.1 BPP Sled-Mechanical Components	33
	3.2.2 Data Acquisition and Recording System (DARS)	35
	3.2.3 Hydroacoustic Assembly	41
	3.2.4 State-of-Health (SOH) Communications	41
	3.2.5 Battery Power Subsystem	41
4.0	Gould Equipment Set-Up, Testing and Operation	43
	4.1 Shipboard Equipment Description	43
	4.1.1 Shipboard Portable Instrumentation Van	43
	4.1.2 Electronic Support Equipment	43
	4.1.3 Mechanical Support Equipment	46
	4.2 DTU Setup, Testing and Operation	47
	4.2.1 Interface Testing at Teledyne Geotech Facilities	47
	4.2.2 Warehouse Staging Prior to Glomar Challenger Deployment	48
	4.2.3 DTU Deployment and Operational Testing	49
	4.3 BPP Set-Up, Testing, and Operation	51
	4.3.1 Dockside Staging	51
	4.3.2 Shipboard Activities	51
5.0	MSS System Deployments and Recovery	56
	5.1 Leg 88/1982 Northwest Pacific Deployment Attempt	56
	5.2 Leg 91/1983 South Pacific Deployment and Recovery	57
	5.2.1 MSS/83 Deployment	57
	5.2.2 MSS/83 Recovery	61

GOULD

TABLE OF CONTENTS (continued)

Section	Title	Page
6.0	Gould Equipment Performance Analysis	63
	6.1 1982 Deployment Attempt	63
	6.1.1 Silver Zinc Battery Failure	63
	6.1.2 HCD-75 Tape Head Failures	66
	6.2 1983 Deployment and Recovery	67
	6.2.1 Data Transceiver Unit (DTU) Failure	67
	6.2.2 BPP Post Recovery Analysis	68
	6.2.3 Conclusions	75
	6.3 Data Disposition	81
	6.4 Suggested BPP/DTU Improvements	81
Appendix A	Gould MSS Equipment Photographs	A-1
Appendix B	Operating Instructions for Yardney Silvercel Battery	B-1
Appendix C	Shipboard Portable Instrumentation Van Specifications	C-1
Appendix D	MSS User's Manual	D-1
Appendix E	Report Distribution	E-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
1-1	Marine Seismic System Functional Elements (Hactured Elements were designed and Built by Other Contractors)	3
1-2	MSS Physical Configuration (Hastured Elements were Designed and Built by Other Contractors)	4
1-3	Marine Seismic System - Basic Elements	5
1-4A	Bottom Processing Package	6
1-4B	Data Transceiver Unit	7
2-1	Marine Seismic System - Basic Elements	15
2-2	MSS - Modes of Operation, BIP Deployment/Installation	16
2-3	MSS - Modes of Operation, Dual Recording	18
2-4	MSS - Modes of Operation, BPP Deployment	19
2-5	MSS - Operational Mode	20
2-6	Data Transceiver Unit Configured in BIP	22
3-1	BIP Data Transceiver Unit (DTU) Configuration within the GEOTECH Model 53100 BIP	28
3-2	BIP Data Transceiver Partitioning	29
3-3	MSS Electrical/Mechanical (EM) Cable	31
3-4	MSS - Bottom Processing Package - Mechanical Configuration	34
3-5	MSS - Data Acquisition and Recording Sphere and Interfacing Equipment	36
3-6	DARS System Timing Diagram	38
4-1	Test Equipment Rack	44
4-2	MSS/1983 BPP Pre-Deployment Shipboard Test Mode Configuration (Top View)	50
6-1	Burned Silver Zinc Battery Cell	65
6-2	Pressure Cable Jacket Failure	70
6-3	Pressure Connector Cross Section	76
6-4	Pressure Cable Cross Section Detail	77
6-5	Battery Vessel Configuration	78
6-6	Pressure Connector Pin Insert	79

LIST OF TABLES

Table	Title	Page
1-1	MSS DTU/BPP Development and Deployment Schedule	9
1-2	Lessons Learned	13
3-1	FSK Channel Pair Allocations	32
3-2	One Second DIA to DAC Block Format	39
5-1	Gould Activities During MSS '83 Deployment Exercise	58
?	Gould Activities During MSS '83 Recovery Exercise	62

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GLOSSARY OF ACRONYMS

ADC	Analog-to-Digital Converter
AIO	Auxiliary Input/Output
BCD	Binary Coded Decimal
BIP	Borehole Instrumentation Package
BPP	Bottom Processing Package
CAL	Calibration
CDR	Critical Design Review
C/F	Controller/Formatter (HCD-75)
CFB	Controller/Formatter Bus (HCD-75)
CMOS	Complementary Metal Oxide Semiconductor
COMM	Communication
CRC	Cyclic Redundancy Check
CTR	Controller
DAC	Data Acquisition Controller
DARPA	Defense Advanced Research Projects Agency
DARS	Data Acquisition and Recording System
dB	Decibel
DBM	Data Buffer Memory
DCASMA	Defense Contract Administration Services Management Area
DED	Defense Electronics Division of Gould Inc.
DIA	Data Input Assembly
DMA	Direct Memory Access
DSA	Data Storage Assembly
DSC	Data Storage Controller
DSDP	Deep Sea Drilling Project

GLOSSARY OF ACRONYMS (Continued)

DSI	Data Storage Interface
DTU	Data Transceiver Unit
EDME	Enhanced Delta Modulation Encoder
E	East-West Sensor Channel
EM	Electro-Mechanical (Cable)
EOT	End of Tape
EPROM	Erasable Programmable Read Only Memory
FDM	Frequency Division Multiplexed
FFT	Fast Fourier Transform
FIR	Finite Impulse Response (digital filter)
FM	Frequency Modulation
FMT	Formatter
FSK	Frequency Shifted Keyed
GBL	Government Bill of Lading
GFM	Government Furnished Material
GFP	Government Furnished Property
GMDI	Global Marine Development, Inc.
GOES	Geostationary Operational Environmental Satellite
H/A	Hydroacoustic Assembly
HCD	High Capacity Data (3M Cartridge Tape Drive)
HEX	Hexadecimal
Hz	Hertz
IC	Integrated Circuit
I/F	Interface
I/O	Input/Output

GLOSSARY OF ACRONYMS (Continued)

IRR	Installation, Retrieval and Redeployment
ISC	Input Signal Conditioning
LDO	Low Distortion Oscillator
LP	Long Period
LPR	Linear Power Regulator
LSB	Least Significant Bit
MAC	Military Airlift Command
MCB	Micro-Computer Board
MP	Mid Period
MSB	Most Significant Bit
MSEC	Millisecond
MSS	Marine Seismic System
MTBF	Mean Time Between Failure
N	North-South Sensor Channel
NCEL	Naval Civil Engineering Laboratory
NMI	Non-Maskable Interrupt
NORDA	Naval Ocean Research and Development Activity
NSRDC	Naval Ship Research and Development Center
NSS	National Seismic Station
OBS	Ocean Bottom Spheres
PCB	Printed Circuit Board
PCL	Power Cycle Logic
PDR	Preliminary Design Review
PIO	Parallel I/O Controller Chip
PLL	Phase Lock Loop

GLOSSARY OF ACRONYMS (Continued)

PROM	Programmable Read Only Memory
PSI	Pounds Per Square Inch
PSS	Power Sub-System
PWA	Printed Wiring Assembly
RAM	Random Access Memory
RH	Relative Humidity
ROM	Read Only Memory
RTC	Real Time Clock
SBEC	Single Bit Error Correction
SCU	Shipboard Control Unit
SIO	Serial I/O Controller Chip
S/N	Signal-to-Noise Ratio
SP	Short Period
SPS	Switching Power Supply
SOH	State-of-Health
STC	Shipboard Test Console (GEOTECH Van)
TBD	To Be Determined
T/D	Tape Drive (HCD-75)
TDB	Tape Drive Bus (HCD-75)
TDI	Tape Drive Interface (HCD-75)
TER	Test Equipment Rack (Gould Van)
T/O	Time-Out
UTC	Universal Coordinated Time
V	Volts
WWV	World-Wide Time Reference
Z	Vertical Sensor Channel

1.0 SUMMARY

1.1 Introduction

Under the technical guidance of the Naval Ocean Research and Development Activity (NORDA) and the sponsorship of the Defense Advance Research Projects Agency (DARPA) the Gould Defense Electronics Division performed from January 1981 through April 1983 under contract number N00014-81-C-0473 to design, develop and deploy system elements of the Marine Seismic System (MSS). Herein is presented the final report under the MSS contract which documents and defines the system developed and its implementation.

Elements of this report include:

- An overview and summary of the development and deployment including accomplishments, lessons learned, and recommendations for future efforts;
- A description of the operational and functional requirements of the MSS;
- A description of all Gould designed and fabricated equipment;
- A description of the Set-Up, Test and Operation requirements of the Gould developed equipment;
- A description of the system deployment and recovery; and
- A post-deployment performance analysis of the Gould designed equipment.

1.2 Background - System Study and Specification (N00014-79-C-0490)

In 1979 Gould DED performed a feasibility study of an ocean bottom system to collect and record seismic and hydroacoustic data. This effort was sponsored by DARPA and technically managed through their agent NORDA. This study encompassed numerous trade-off analyses covering the topic areas: (a) Environmental Analysis, (b) Seismological Considerations and Analysis, (c) Sensors, (d) Intra-System Communications, (e) Data Acquisition, Processing and System Control, (f) Satellite Telemetry Systems, (g) Power Sources, and (h) Ocean Engineering - Buoy System Design. Following this system study, Gould prepared the development specification for what has been named the Marine

Seismic System (MSS). This specification was completed in late 1980 and served as the cornerstone from which all system designs and developments were initiated.

1.3 System Design, Development and Deployment (N00014-81-C-0473)

Based upon the existing technology, program time constraints, and funding levels the decision was made in late 1981 to pursue a system design consisting of:

a. A borehole seismometer and digitizer package;

b. A bottom mounted data recording, power and hydroacoustic sensor package; and

c. A subsurface buoyant and acoustically activated retrieval and recovery system.

System deployment would be accomplished utilizing the Glomar Challenger drill ship and one support vessel.

The MSS system development team was formed and given the following tasks: (1) Global Marine Development Corporation would design and implement all systems needed to deploy the system; (2) Teledyne Geotech would develop the seismic sensor, its associated electronics and pressure vessel and a shipboard data recording system; (3) The Naval Civil Engineering Laboratory (NCEL) would design the physical platform for the ocean bottom electronics and the ocean bottom electronics retrieval system; (4) Gould Defense Electronics Division would build the hydroacoustic sensor, power system, all ocean bottom data acquisition and recording systems and a shipboard data recording system; and (5) NORDA would serve to direct, coordinate and facilitate all team members and program activities.

The major elements of the MSS are shown in Figure 1-1 with their physical configuration shown in Figure 1-2. Those elements shown without hastured lines were designed and fabricated by Gould. An artist conception of the system as deployed is shown in Figure 1-3 with photographs (and callouts) of the Bottom Processing Package and the Data Transceiver Unit (DTU) portion of the Borehole Instrumentation Package (BIP) shown in Figures 1-4A and B.

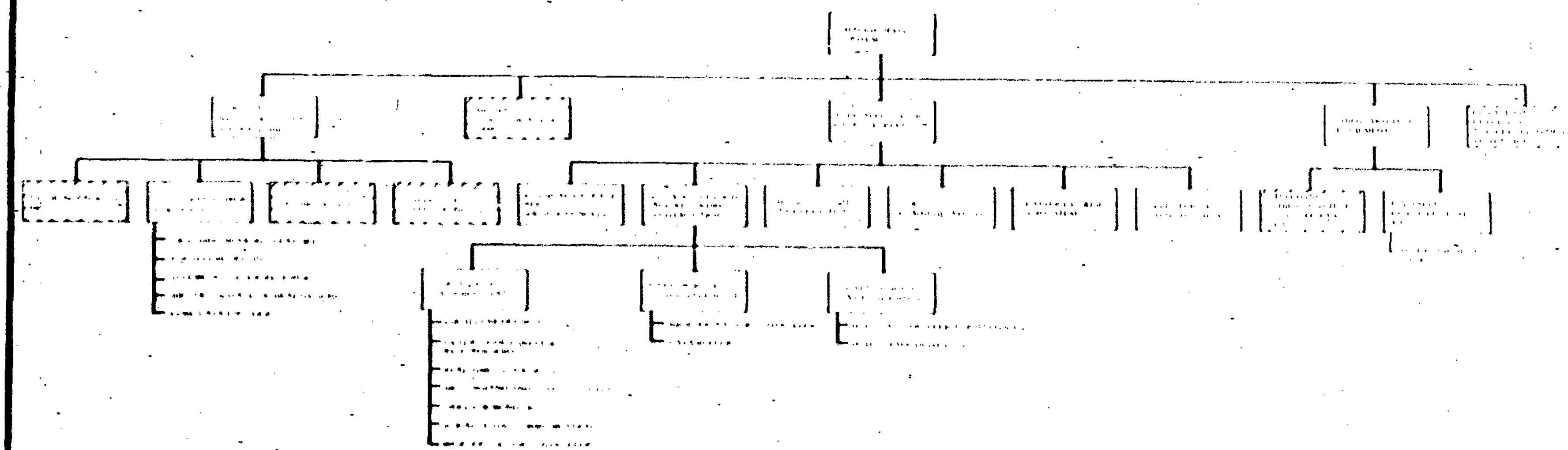


Figure 1-1. Marine Seismic System Functional Elements (Hactured) Elements were designed and Built by Other Contractors)

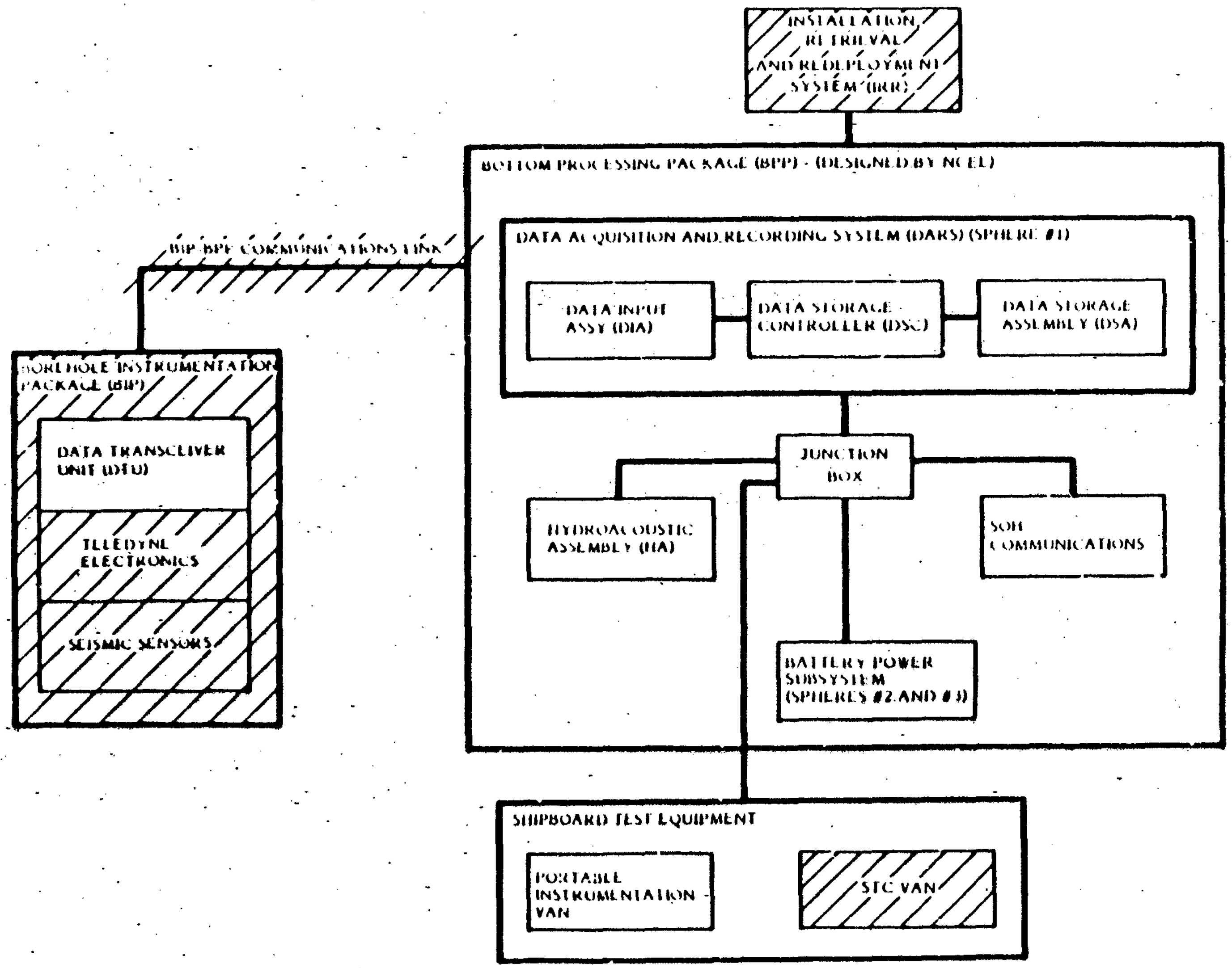


Figure 1-2. MSS Physical Configuration (Hastured Elements were Designed and Built by Other Contractors)

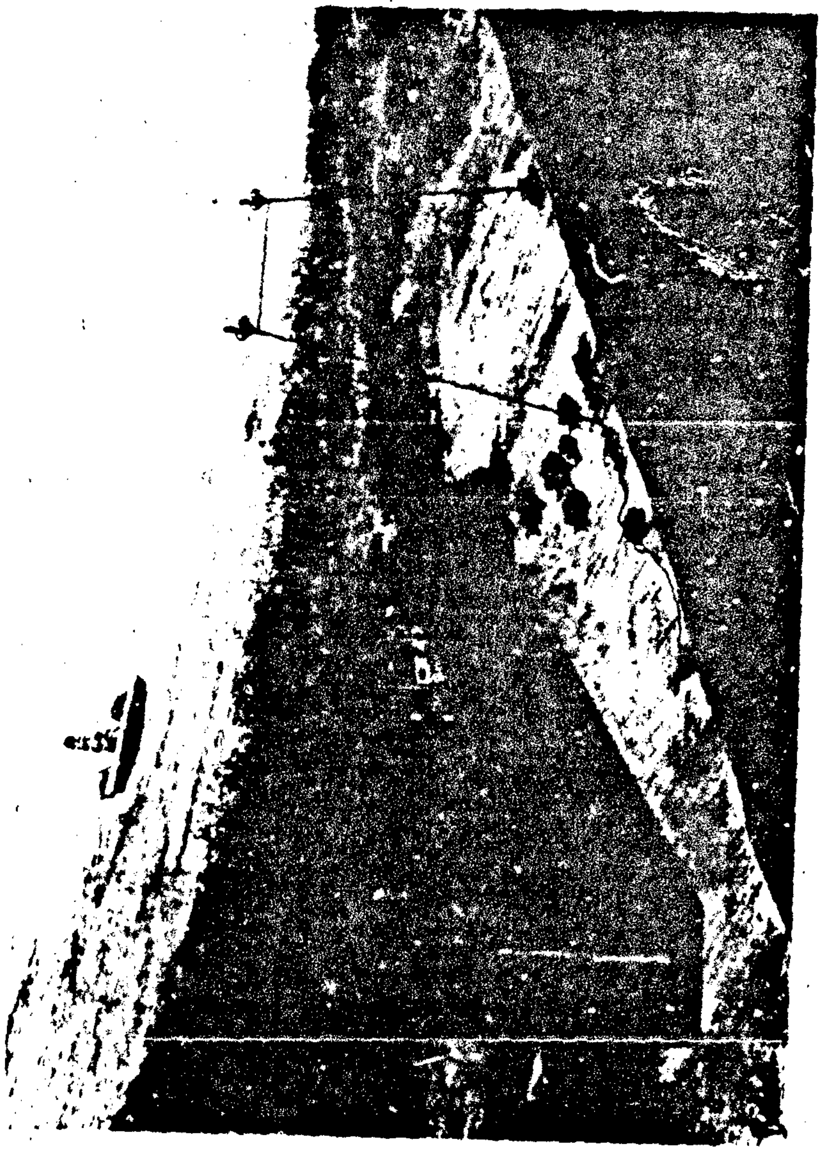


Figure 1-3. Marine Seismic System - Basic Elements

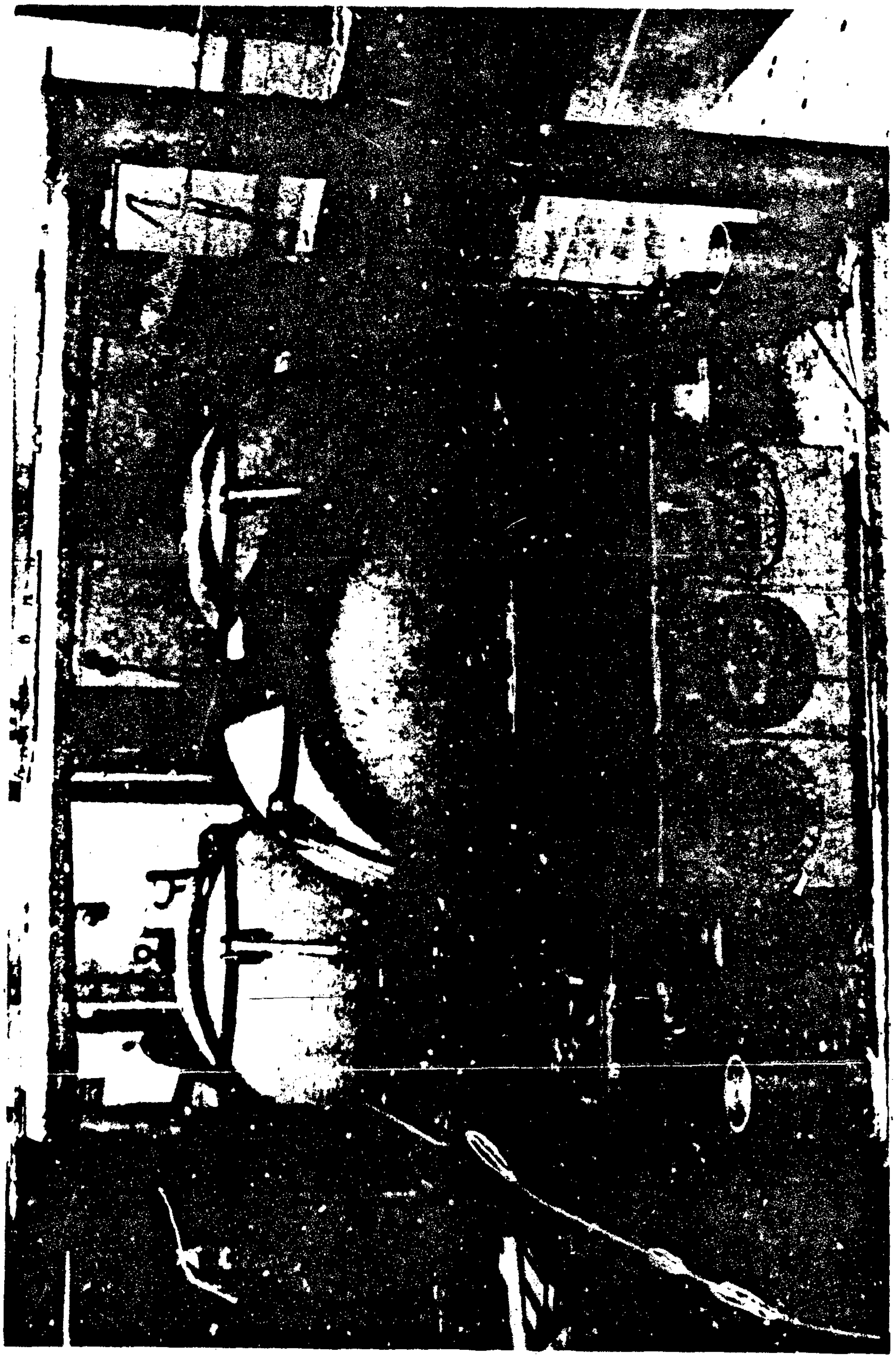


Figure 1-4A. Bottom Processing Package

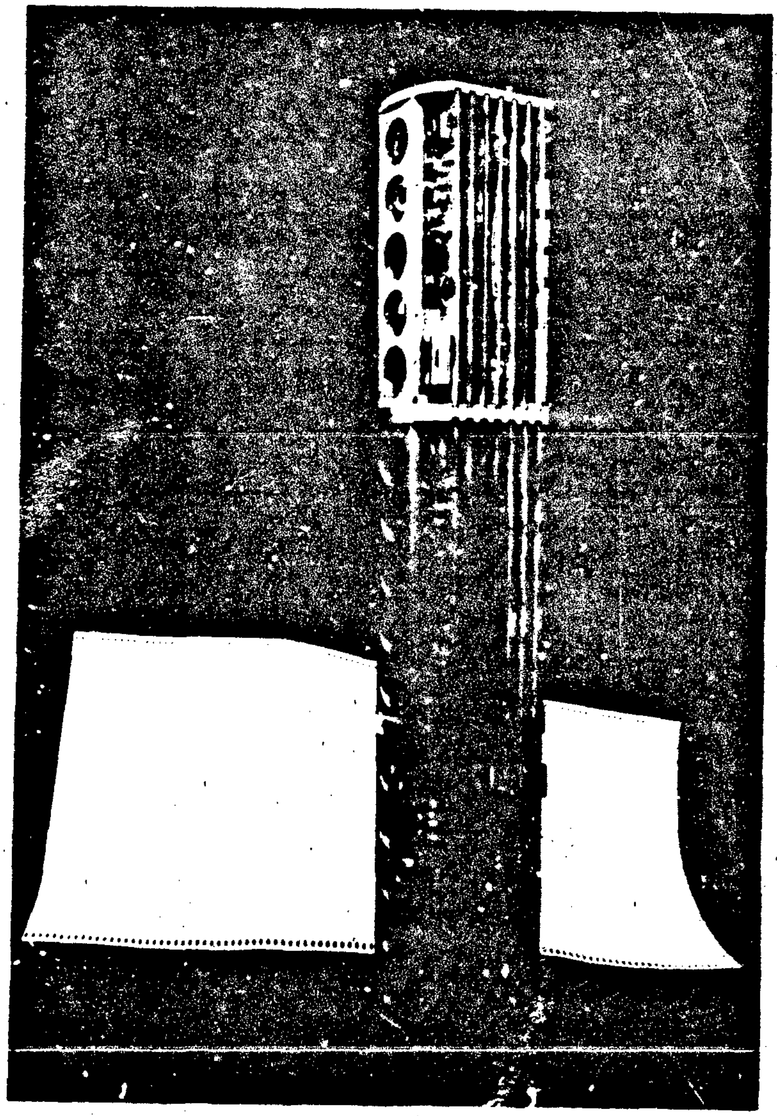


Figure 1-4B. Data Transceiver Unit

Design and development of all Gould developed systems began in January 1981. By early 1982 the major electronic assemblies of the MSS were developed and integration testing had begun. With integration testing complete by mid-summer all systems were shipped to Japan and readied for deployment. The North Pacific system deployment attempt began in the late Summer of 1982; however, it was aborted due to drilling problems. Two problems occurred with the Gould equipment during this deployment attempt: (1) the internal shorting and the subsequent violent destruction of one of the two Silver Zinc batteries while the system was in Japan; and (2) the failure of HCD-75 tape recorder heads due to a 3M manufacturing problem (process control). These problems were corrected prior to the aborted system deployment. By the Winter of 1983 a second deployment was attempted with success; however, upon system retrieval it was learned that data acquisition had abruptly terminated 40 hours, 16 minutes and 25 seconds into the mission. Post deployment analysis revealed a pressure failure and massive short in the primary battery cable. The failure shorted the battery wires in the high pressure connector and allowed water to penetrate one of the two battery spheres. All data collected during the mission was turned over to NORDA for processing and analysis. Table 1-1 provides a chronology of the system development and subsequent deployment.

1.4 Accomplishments and Lessons Learned (Recommendations)

Although only 40 hours of seismic and hydroacoustic data were collected with the system fully deployed, the MSS program can certainly be called a success. The only major program failing was in the quantity of data collected. The Gould developed electronics provided the highest quality (i.e., highest fidelity and dynamic range) seismic and hydroacoustic data ever recorded. Furthermore, the data recording system employed in the MSS was the largest capacity, remotely deployed and powered recording system ever used with over 10 billion bits of storage capability.

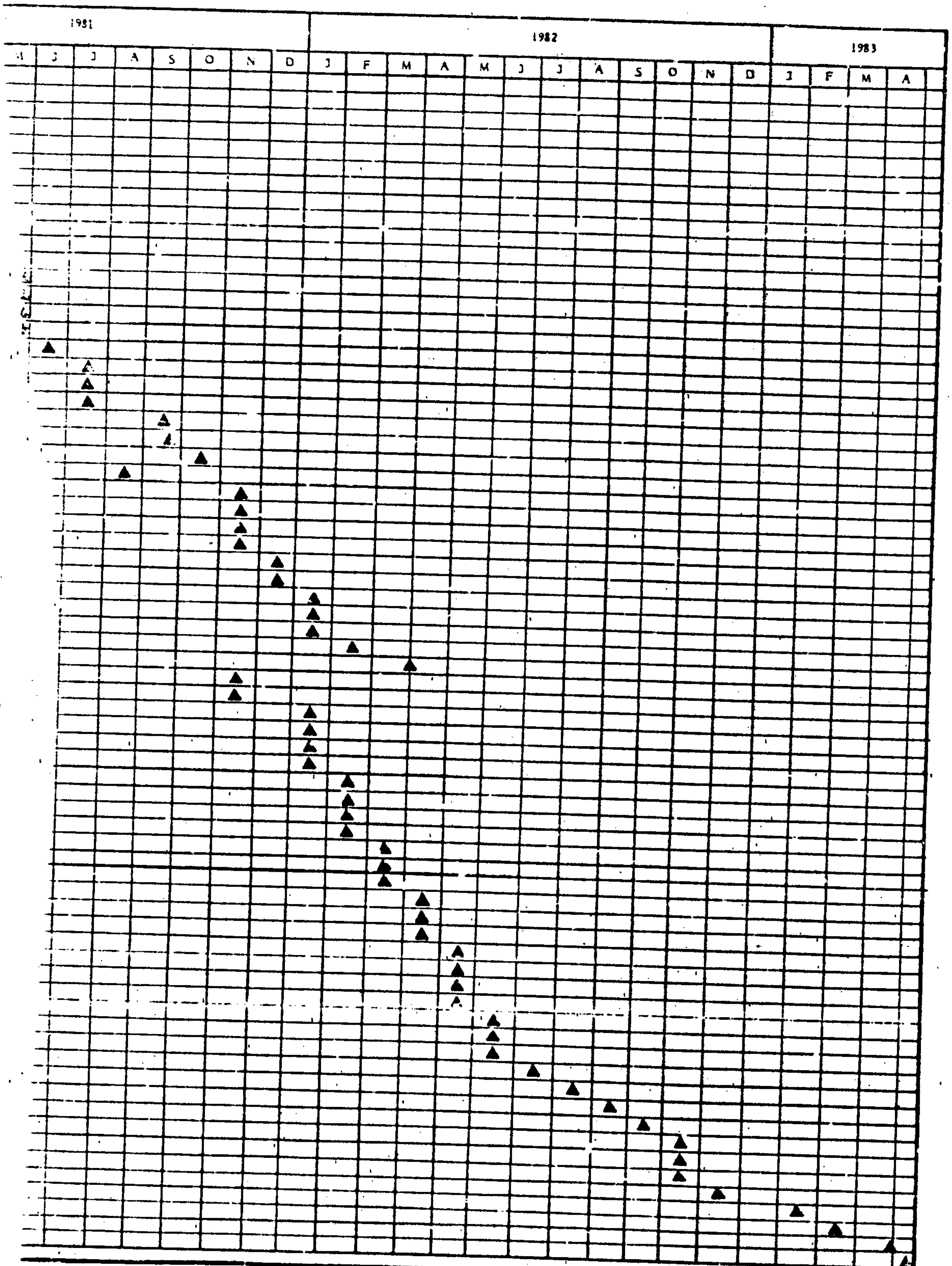
The important questions to ask following the system deployment are: (1) What did we do right, (2) What did we do wrong, and (3) If we could start fresh, what would we do

Table 1-1. MSS DTU/BPP Development and Deploy

Phase	Activity	1981 J	F	M	A	M	J	J	A	S	O	N	
DESIGN PHASE	CONTRACT AWARD	▲											
	INITIATED SYSTEM DESIGN	▲											
	INITIATED DETAIL DESIGN OF DIGITAL HARDWARE	▲											
	INITIATED SOFTWARE DEVELOPMENT	▲											
	INITIATED PACKAGING/MECHANICAL DESIGN		▲										
	COMPLETED EVALUATION OF DIGITAL VS FM TELEMETRY		▲										
	COMPLETED INITIAL BREADBOARD AND TEST OF EDME & FSK TELEMETRY		▲										
	SYSTEMS ENGINEERING COMPLETE-DESIGN DISCLOSURES COMPLETE			▲									
	PRELIMINARY DESIGN REVIEW				▲								
	MECHANICAL DESIGN PRESSURE VESSEL REQUIREMENTS COMPLETE				▲								
	POWER SUBSYSTEM CONCEPT DESIGN COMPLETE				▲								
	DEMONSTRATED EDME/FSK/FIR FILTER CONCEPT					▲							
	COMPLETED DESIGN AND FABRICATION OF DIGITAL HARDWARE					▲							
	INITIATED DESIGN OF DATA TRANSCEIVER UNIT					▲							
	COMPLETED DARS PACKAGING DESIGN					▲							
	COMPLETED HYDROACOUSTICS ELECTRONICS DESIGN, START TEST					▲							
	COMPLETED DATA STORAGE CONTROLLER FIRMWARE, START TEST						▲						
	COMPLETED DATA ACQUISITION CONTROLLER FIRMWARE, START TEST							▲					
	COMPLETED DATA TRANSCEIVER UNIT DESIGNS							▲					
SYSTEM RE-CONFIGURATION	INITIAL REQUEST TO RECONFIGURE SYSTEM PACKAGING							▲					
	INITIATED ASSEMBLY AND INTEGRATION OF PROTOTYPE DTU									▲			
	SYSTEM ARCHITECTURE AND PACKAGING RE-DEFINED									▲			
	NCEL TASKED WITH BOTTOM PROCESSING PACKAGE DESIGN										▲		
DARS FABRICATION & TEST	COMPLETED FABRICATION AND TEST OF FIR FILTERS								▲				
	COMPLETED INTEGRATION AND TEST OF PROTOTYPE DTU											▲	
	COMPLETED SECOND PHASE OF SYSTEM TESTING											▲	
	SWRI CONTRACTED TO DESIGN J-BOX/EXTERNAL CABLING											▲	
	DECISION MADE NOT TO POWER CYCLE HCD-75 TAPE DRIVES AND C/F											▲	
	RECEIVED AND COMPLETED TEST OF ALL 20 TAPE DRIVES												▲
	COMPLETED BIP - DARS COMMUNICATION TESTS												▲
	COMPLETED FABRICATION AND INTEGRATION OF DTU #2												
	COMPLETED INTEGRATION OF 20 TAPE DRIVES WITH DSC												
	COMPLETED RE-DESIGN OF ELECTRONIC PACKAGING												
	COMPLETED FABRICATION AND INTEGRATION OF DTU #3												
	COMPLETED DESIGN & FABRICATION OF HYDROACOUSTIC SENSOR												
BPP FABRICATION	INITIATED REFURBISHMENT OF PRESSURE VESSELS											▲	
	INITIATED EVALUATION OF AgZn VS LITHIUM BATTERIES											▲	
	DECISION MADE TO USE AgZn BATTERIES												
	SWRI COMPLETED J-BOX AND ELECTRICAL CONNECTION DESIGN												
	RECEIVED PRELIMINARY BILL OF MATERIAL FOR BPP FROM NCEL												
	COMPLETED PRESSURE TEST OF VESSELS AT NSRDC												
	INITIATED FABRICATION OF DARS PACKAGING												
	NCEL COMPLETED BPP DESIGN												
	INITIATED FABRICATION OF J-BOX AND ELECTRICAL HARDWARE												
	INITIATED FABRICATION OF SPHERE MOUNTS												
	COMPLETED SPHERE REFURBISHMENT												
	INITIATED FABRICATION OF BPP												
	PROTOTYPE AGZN CELL TESTED												
	COMPLETED FABRICATION OF J-BOX AND ELECTRICAL HARDWARE												
	COMPLETED FABRICATION OF SPHERE MOUNTS												
	COMPLETED PRESSURE TEST OF SPHERES AND ANCILLARY HARDWARE												
	COMPLETED BOTTOM PROCESSING PACKAGE FABRICATION												
	[illegible]												
	COMPLETED DARS INTEGRATION INTO SPHERE PACKAGE												
SYSTEM TESTING	INITIATED FINAL SYSTEM PERFORMANCE TESTS												
	[illegible]												
	COMPLETED BPP MECH - ELEC ASSEMBLY												
	COMPLETED SYSTEM PERFORMANCE TESTS												
DEPLOYMENT	SHIPPED SYSTEM TO HAKODATE, JAPAN, INITIATED STAGING												
	SYSTEM LOADED ON BOARD GLOMAR CHALLENGER - DEPLOYMENT												
	DEPLOYMENT TERMINATED, OFF-LOADED SYSTEMS IN YOKOHAMA, JAPAN												
	EQUIPMENT RECEIVED AT GOULD FACILITY												
	REFURBISHED SPHERES AND BPP												
	DESIGNED AND IMPLEMENTED MODIFICATIONS TO HARDWARE/FIRMWARE												
	RE-TESTED SYSTEM												
	SYSTEM SHIPPED TO WELLINGTON, NEW ZEALAND												
	SYSTEM DEPLOYED												
	SYSTEM RETRIEVED												
	SYSTEM RECEIVED AT GOULD FACILITY												
	SYSTEM EVALUATION												

1 of 2

SPP Development and Deployment Schedule



20/2

differently. It should be realized that the issue of what was done wrong was in most cases precipitated by cost and schedule constraints and not by design or implementation error. Also much of what would be done differently today can be attributed to technological evolution.

First, what we did right:

1. The basic system architecture and partitioning is correct and maximizes reliability and commonality throughout the system. Putting the analog circuits near the sensor minimized distortion and thus maximized system fidelity;
2. The sensor suite selected is correct. The data from these sensors, once processed, should further our knowledge of earthquake and explosion seismology;
3. Use of the EDME (i.e., linear digitization) versus the compromising gain ranging approach provides the analyst with 40 dB more fidelity and dynamic range than previously obtainable;
4. Although the HCD-75 recording system was "new technology" in 1981 (as noted by our purchase of serial number 1) it offered the MSS the only reasonable approach to mass data storage (i.e., in terms of size, weight, and power consumption per bit of data recorded); and
5. The Silver Zinc batteries worked well in the MSS application and from a political point of view were the correct choice. However, from an engineering point of view the Lithium Thionalchloride batteries presented a better known, safer and simpler implementation alternative.

What we did wrong:

1. System testing cannot be over-emphasized, especially for a system that must operate unattended for 45 days in a harsh deep ocean environment. Full configuration system testing was never conducted due to schedule constraints (i.e, was governed not by system development issues but rather

by the Glomar Challenger's schedule, and by weather windows needed to drill the borehole and deploy the system). Other system testing shortcomings include:

- Minimal testing of the power system.
- Minimal pressure testing of the mechanical assemblies and no pressure testing of late purchased spare assemblies;

2. System spares were not complete, which presented the deployment team with unnecessary problems;
3. Failure modes associated with the complete loss of one power sphere were not contemplated, designed against, and therefore never tested; and
4. The FSK telemetry used between the DTU and DARS presented the deployment team with many problems. Instabilities were observed in the FSK telemetry once the BIP was deployed and data was being taken aboard ship. It is assumed that these instabilities arose due to temperature, pressure and/or tension gradients on the coax (i.e., data/power cable) suspended between the BIP and the ship. As this level of instability was never experienced previously we do not believe it existed once the BPP was positioned on the ocean bottom and all cable gradients were removed. This does however point to a system deficiency and one which should be designed out prior to future deployments. This can be done either by replacing the BIP/BPP cable with a multi-twisted pair arrangement or changing the telemetry to a Time Division Multiplexing scheme.

What we would do differently if we started the development today:

1. Be realistic about testing requirements and not let the deployment ship drive the schedule. The development schedule should allow for a minimum of six months system level testing and should include a dry run of a full mission (i.e., 45 days);

2. Select one contractor to be responsible for all system integration and testing;
3. Define and purchase all spare parts early in the program and fully test each spare as if it were the prime system component;
4. Spare the system to a more complete level;
5. All system elements to be exposed to ocean ambient conditions should be subjected to repeated, multi-hour pressure tests;
6. Reconsider the use of Lithium Thionalchloride batteries to power the MSS. If from a density, cost and safety point of view they are a better choice than Silver Zinc batteries, fight the political battle;
7. Re-partition the power design to allow for continuous system operation from one battery;
8. Use 16 bit CMOS microprocessor technology to control the system as opposed to the 8 bit NMOS technology available in 1981. This will serve to reduce power, size and simplify the system design;
9. Use hybrid EDME, FIR filter and microprocessor circuits located near the sensor. This will substantially reduce power and space requirements and greatly simplify the telemetry requirements;
10. Design the system to fit within a single pressure vessel. The use of Lithium Thionalchloride batteries, hybrid circuits, and 16-bit microprocessors will reduce system volumetric requirements; and
11. Detailed mechanical and electrical improvements to the BPP and DTU packages as defined in Section 6, paragraph 6.4, "Suggested BPP/DTU Improvements."

A summary of the above information is shown in Table 1-2.

Table 1-2

Lessons Learned

What We Did Right	What We Did Wrong	What We Would Do Differently Today
1. Correct System Architecture	1. Insufficient Testing a. Power System b. High Pressure Testing c. System Level Testing	1. Increase test time to 6 months minimum. Also perform 45-day dry run system operation.
2. Sensor Suite	2. Sparing Levels	2. Prime contractor for system integration and testing.
3. Use of EDME	3. Power Partitioning	3. Early purchase of spares coupled with complete testing.
4. Use of HCD-75	4. Telemetry/Cable Design	4. More complete spare levels.
5. Use of AgZN Batteries		5. More and repeated high pressure testing.
		6. Reconsider the use of Lithium Thyonal-Chloride batteries.
		7. Re-partition power system design.
		8. Utilize 16 bit micros.
		9. Utilize hybrid technology.
		10. Design to fit within a single pressure vessel.
		11. Detailed BPP/DTU improvements.

2.0 MSS SYSTEM DEFINITION

The basic elements of the deployed MSS as shown in Figure 2-1. Seismic motion is sensed and converted into a digital data stream by the Borehole Instrumentation Package (BIP). The data is transmitted over a single Electro-Mechanical (EM) coaxial conductor cable to the Bottom Processing Package (BPP). The BPP continuously acquires and stores the data in real-time for up to 45 days. A hydroacoustic sensor is also located on the BPP with its data acquired and stored synchronously with the seismic data. Power to operate the BIP and BPP electronics is provided by two silver-zinc batteries located on the BPP. The BPP is deployed and retrieved by the mooring system, which is referred to as the Installation, Retrieval and Re-deployment (IRR) hardware. The system is designed to operate in water depths of up to 6,000 meters.

Gould DED's support of the MSS 82/83 missions covers the design, development, fabrication, testing, deployment and retrieval support of the:

- Bottom Processing Package (BPP) consisting of a Data Acquisition and Recording System (DARS), Power Subsystem, Hydroacoustic Assembly, State-of-Health Communication Assembly, and junction box.
- Data Transceiver Unit (DTU) located within the Borehole Instrumentation Package (BIP); and
- Shipboard support equipment housed within the Portable Instrumentation Van consisting of the Test Equipment Rack (TER) and various related peripheral equipment.

2.1 MSS Subsystem Configurations and Modes of Operation

The development of the MSS mission equipment required the capability of configuring into various operational modes:

- BIP Deployment/Installation - Reference Figure 2-2. The GEOTECH Shipboard Test Console (STC) van was used to monitor the Borehole Instrumentation Package (BIP) during the BIP deployment, installation and verification. Although the BIP contained Gould's Data Transceiver Unit (DTU), the DTU was not activated or verified until the dual recording mode;

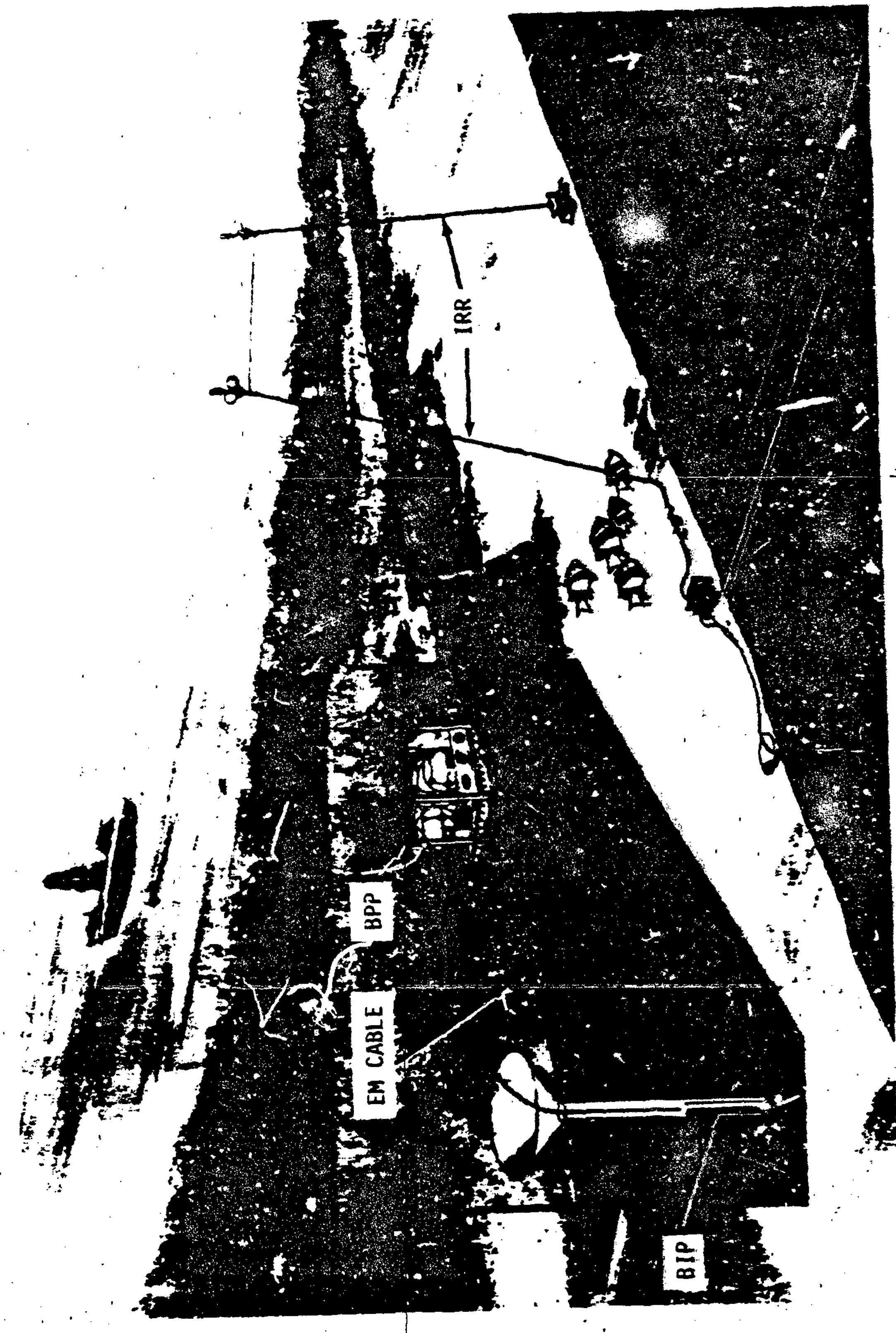


Figure 2-1. Marine Seismic System - Basic Elements

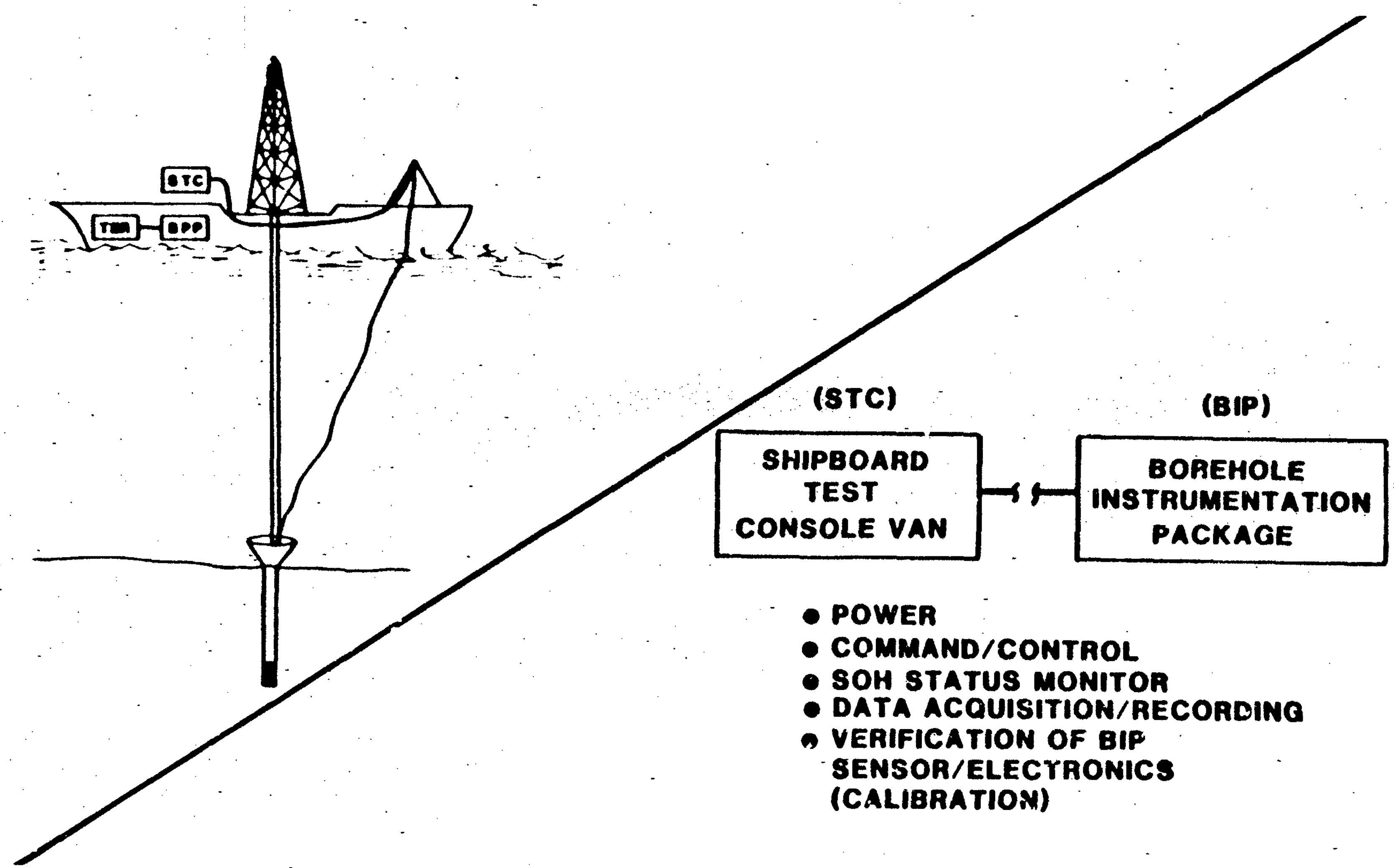


Figure 2-2. MSS - Modes of Operation, BIP Deployment/Installation

- Dual Recording - Reference Figure 2-3. Once the BIP was deployed and installed, the Gould and GEOTECH equipment was configured to record BIP seismic data for five days. As shown, the GEOTECH STC acquired, displayed and recorded data from the BIP electro-mechanical (EM) cable in parallel with the Gould equipment. The Gould Bottom Processing Package (BPP) was used to acquire BIP data/status, transmit BIP commands and provide BIP power. Acquired BIP data was then passed by the BPP to the Gould Test Equipment Rack (TER) for display and recording;
- BPP Deployment - Reference Figure 2-4. At the completion of the dual recording mode, the GEOTECH STC was removed from the EM cable and the BPP data sampling clock was synchronized to the shipboard WWV receiver time. During the lowering of the BPP to the ocean floor, the BPP transmitted state-of-health (SOH) status messages to the shipboard TER; and
- Operational Mode - Reference Figure 2-5. The BPP was pre-programmed to begin the 45 day operational mode 4 hours after initiation of the BPP installation mode. The BPP was pre-programmed for a 45 day data acquisition/storage scenario. Under this scenario BIP seismic data/status, hydroacoustic data, and BPP status were recorded on cartridge tape with calibration commands periodically initiated to the seismic and hydroacoustic sensors.

2.2 BIP Data Transceiver Unit (DTU) Function Requirements

Two of the goals of building and deploying an MSS were: to determine if the seismic signal-to-noise (S/N) as recorded in an ocean bottom borehole is higher than the level recorded by a seismic sensor placed directly on the ocean bottom, and to record seismic events for research purposes using a borehole sensor located on the oceanic side of and at regional distances from a major crustal subduction zone (a trench system).

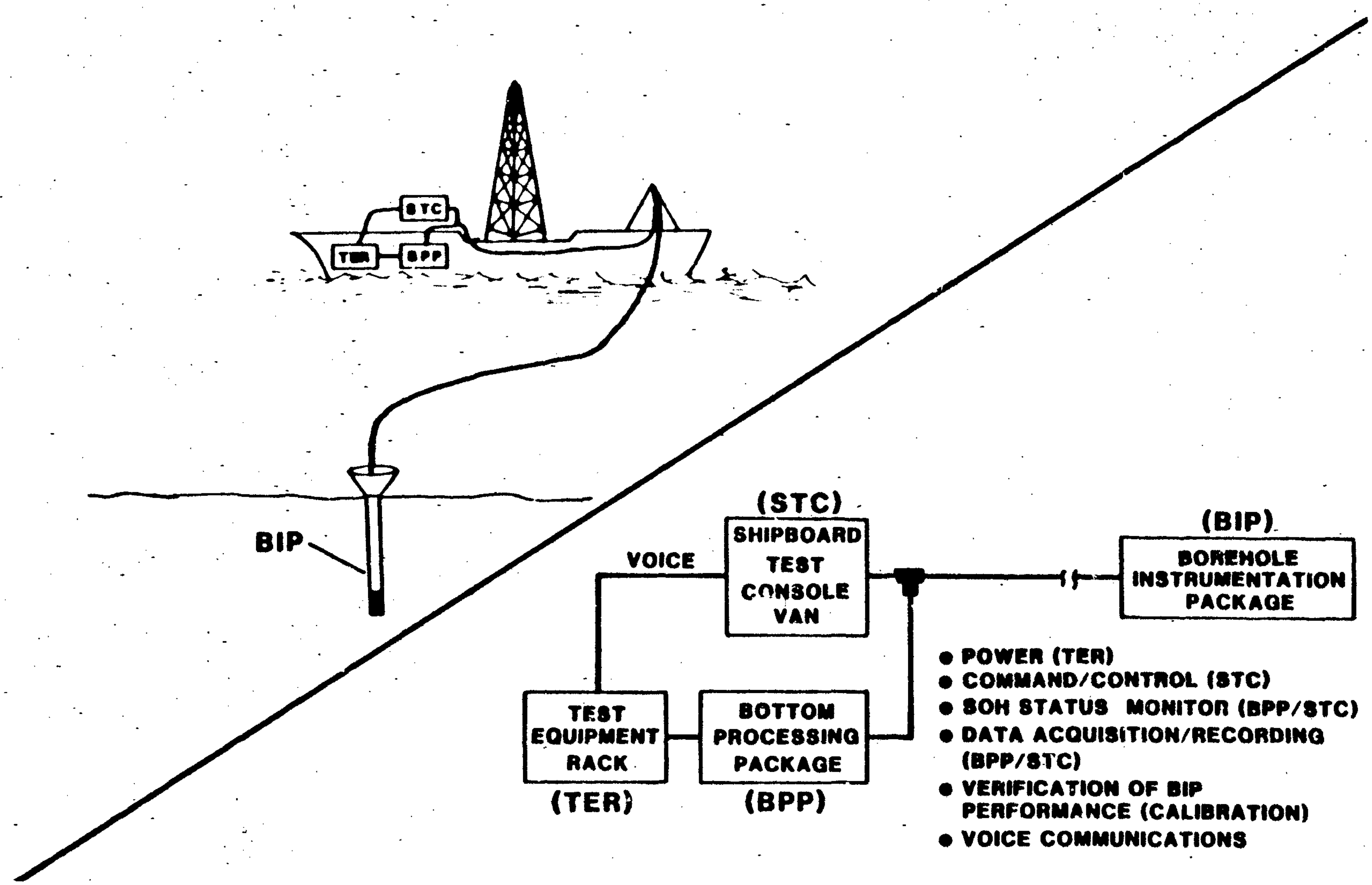


Figure 2-3. MSS - Modes of Operation, Dual Recording

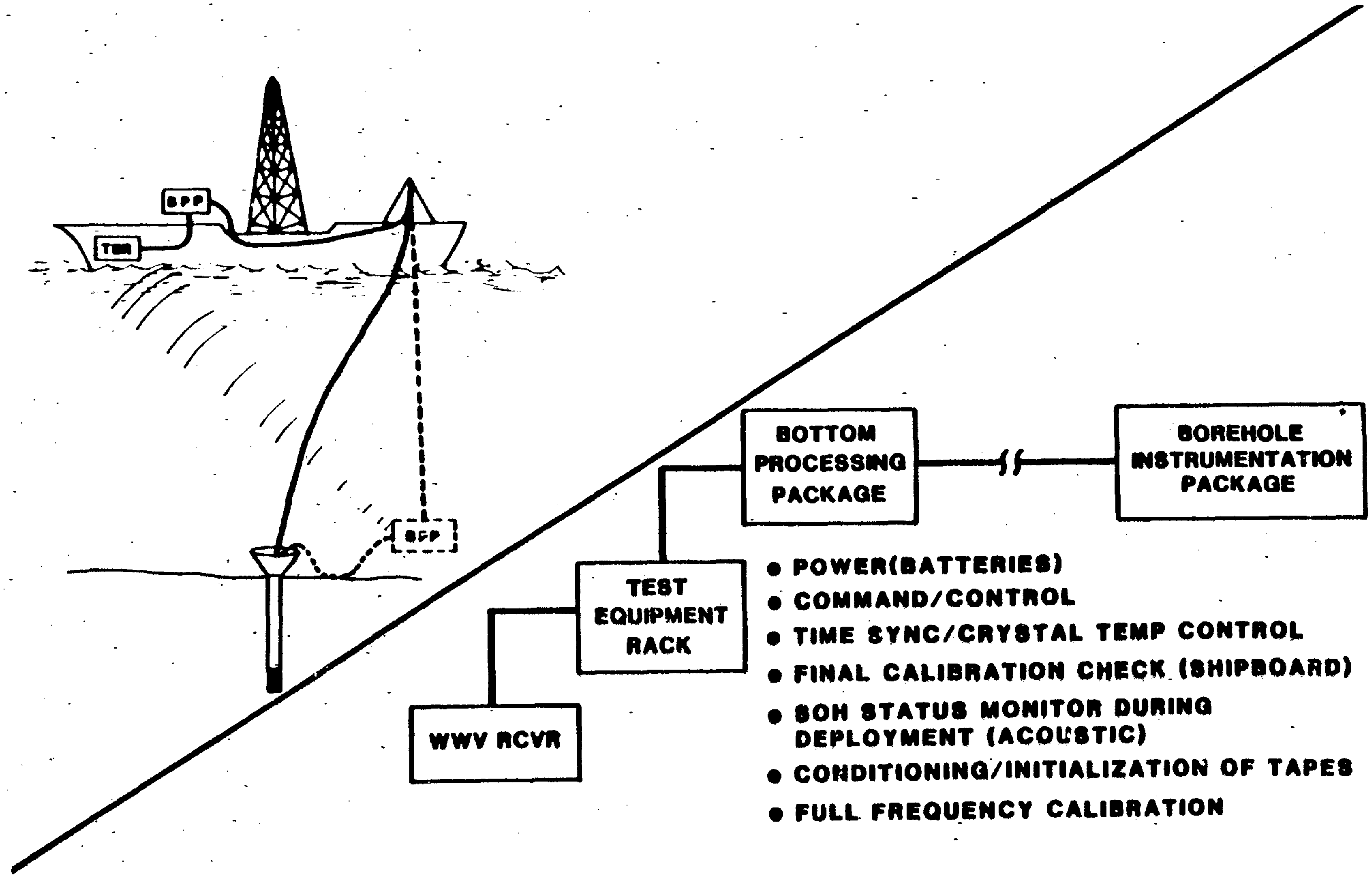


Figure 2-4. MSS - Modes of Operation, BPP Deployment

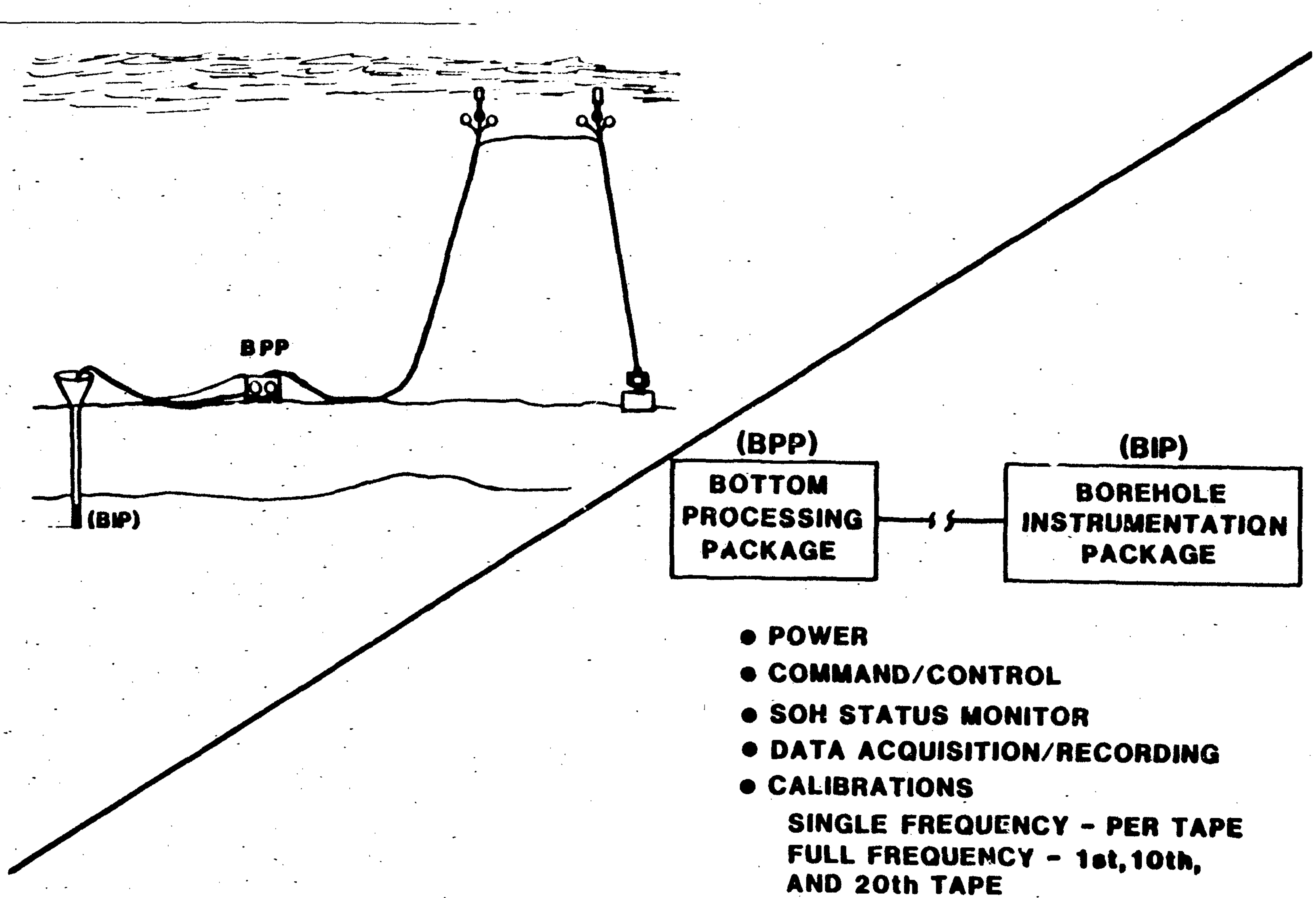


Figure 2-5. MSS - Operational Mode

To meet these goals, the Gould developed Enhanced Delta Modulation Encoder (EDME) was used to digitize each seismic channel and provide 120 dB dynamic range with 24-bit linear data sampling. This approach provided highly reliable, consumed little power and provided a compact configuration for digitization within the BIP.

Frequenc Multiplexed (FM) FSK communications were used over a single EM coax cable to supply BIP commands, a 81920 Hz telemetry clock and power to the BIP; and a 1024 Hz data rate clock, BIP status, three channels of 1024 bps mid-period data and four channels of 10240 bps short period data from the BIP to the DARS. This approach provided a highly reliable communications medium and allowed a minimum hardware configuration in the BIP Data Transceiver Unit (DTU).

Figure 2-6 shows the DTU assembly as it was deployed within the BIP on the South Pacific ocean bottom during the spring of 1983. A complete description of all board types can be found in Section 3.1.1. The Data Transceiver Unit (DTU) contains seven Enhanced Delta Modulation Encoders (EDME): four short period and three mid-period EDMEs. Data from the EDMEs was transmitted via a low power Frequency Shift Key (FSK) telemetry system over the 9 km coax cable to the Data Acquisition and Recording System (DARS) located within the Bottom Processing Package (BPP). The DARS was designed to record up to 1.3 billion bytes of acquired digitized data over a 45 day period. The entire MSS system was powered from batteries located on the BPP sled. Specific DTU functional requirements consist of:

- Three-component, short-period seismic data sampled in the 0.5 to 15.0 Hz bandwidth at 40 s/s with 120 dB dynamic range and linear 24-bit data samples (redundant sampling of the short-period vertical channel, selectable at deployment time, it also provided);
- Three-component mid-period seismic data sampled in the 0.05 to 1.5 Hz bandwidth at 4 s/s with 120 dB dynamic range and 24-bit samples;

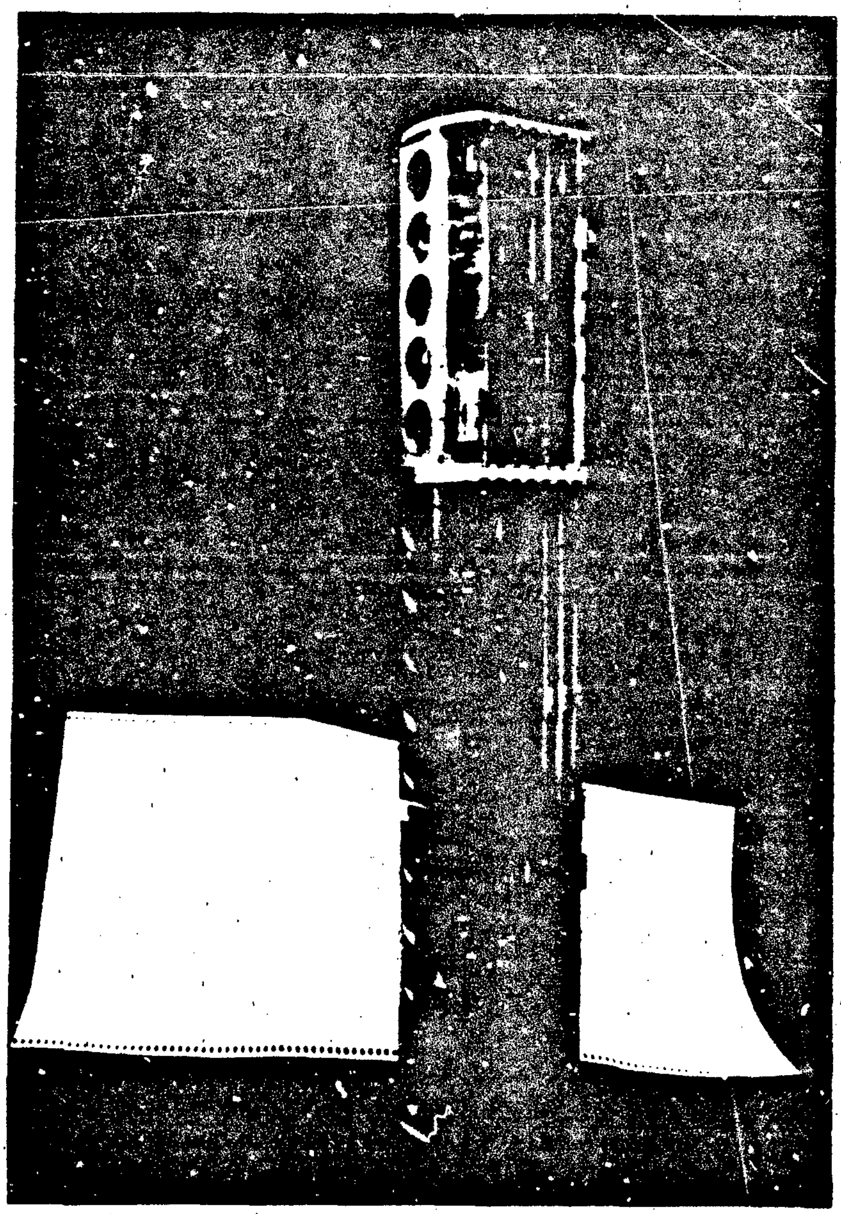


Figure 2-6. Data Transceiver Unit Configured in BIP

- FSK telemetry communications of synchronously sampled data between the BIP and BPP over the 9 km coax cable;
- Periodic sensor calibration via BPP control; and
- Provide BIP generated status messages to the BPP.

2.3 Bottom Processing Package (BPP) Functional Requirements

The BPP sled was configured with one sphere containing data acquisition and recording electronics, two spheres containing batteries, and hydroacoustic sensor assembly, SOH surface communicator, and cable junction box. See Appendix A for photographs of this equipment.

The BPP spheres were configured to contain battery packs in two spheres and DARS electronics in the third. Once the FSK data was decoupled from the EM cable, digital FIR filters were used to bandpass decimate the mid-period data to four samples/second and the short period data to 40 samples/second. The Data Acquisition Z-80 microcomputer acquired the various sensor channels from the FIR filters, formatted a one-second block and transferred the block to the data storage Z-80 microcomputer. The data storage microcomputer managed mass memory and 20 HCD-75 cartridge tape drives for permanent long-term storage of the sensor data. A hydroacoustic sensor was also mounted on the BPP sled which uses an EDME to provide a 10240 bps data stream to the FIR filter which filtered and decimated the data to 40 samples/second in parallel with the seismic short-period data channels.

During the system development phase extensive system analysis was used to select candidate hardware which would optimize system performance and allow for high system reliability, low power consumption and minimum package size. The resulting BPP (and DTU) design requirements are as follows:

Timing Accuracy: Time sync to ±50 microsecond of WWV 1.0 Hz at deployment time.

Maintain ±20 msec of WWV over 45 days.

Date/time data time-tagging (DDD:HH:MM:SS) to ±1 millisecond data sampling accuracy between data channels.

Signal Dynamic Resolution: 90 dB for Hydroacoustic (minimum) in the 0.5 to 15.0 Hz bandwidth with 0.0025% THD.

120 dB for Seismic (minimum) with 0.0002% THD

Synchronous SP-Z, SP-Z backup, N, E; MP-Z, N, E; and Hydroacoustic sampling and digitization

Data Format: 16-bit Hydroacoustic and SOH data; 24-bit SP/MP seismic data

Sampling Rates:

Primary Sensor Channels	Hydroacoustic	40 s/s single channel (1st 30 days only)
	SP seismic	40 s/s Z and Z backup channels (45 days, Z or ZB)
	SP seismic	40 s/s N, E channels (1st 22.5 days only)
	MP seismic	4 s/s Z, N, E channels (45 days)
Secondary Sensor Channels	BIP SOH data	1 s/m (received via BIP status)
	DARS SOH data	1 s/m time mux (32 Ch max)

Each BIP/DARS SOH channel to be stored once a minute with the DARS SOH channels defined as follows:

3 - Temperature Sensors

1 - Pressure Transducer

1 - Primary Battery Monitor

2 - Relay Battery Monitors

8 - dc/dc Power Monitors

2 - ADC Status Monitors

9 - Spare Channels

Data Storage:

Data Sampling Requirements

	Bytes/Second	No. Days
Time/Status/SOH	9	45
MP/Z/N/E	36	45
SP-Z (40 s/s, 24 bit)	120	45
SP-N/E (40 s/s, 24 bit)	240	22.5
Acoustic (40 s/s, 16 bit)	80	30

Data Storage Requirements

22.5 days – 540 hours/38.18 hours per cartridge = 14.14 cartridge
485 bytes/second = 269 seconds/128 K DBM dump

8 days – 192 hours/75.66 hours per cartridge = 2.54 cartridges
(245 bytes/second)

15 days – 360 hours/112.28 hours per cartridge = 3.21 cartridges
(165 bytes/second)

(19.89 cartridges are required for 45 days.)

NOTE

Shipboard recording for 120 hours to require 525 bytes/second which includes MP-Z/N/E, SP-Z/N/E/Z Back-Up. The system to record 9 bytes/second for four hours of DARS deployment in order to record DARS SOH data.

Storage Medium

- 128 k bytes intermediate data storage
- HCD-75 Controller Formatter (2 each, one primary and one backup)
- HCD-75 Tape Drives (20 each)
- 67.1 mbytes/cartridge, 1.342 billion bytes total

Power:

- 185 Watts maximum average discharge rate over 45 days
- DC/DC Converters 70% Efficient
- Silver-Zinc Battery (25 cells per sphere, 2 each)

Sensor Calibrations:

The DARS system to perform an automatic single or full frequency calibration of the primary sensors at the beginning of every cartridge (when data logging is initiated on each cartridge) as follows:

Cartridge No.	Sensor	Frequency (Hz)	Duration
1-20	Hydroacoustic	3 Hz Fundamental Square Wave	60 seconds
2-12 14-19	BIP S-750 (Single Freq)	1 Hz	32 seconds
1, 13, 20	BIP S-750 (Full Freq)	16 Hz through .0078125 Hz	one hour approx.
Diagnostic	DTU EDME Calibration	Step Cal	10 seconds

Environmental:	Shipping	-60 to +60° C	0-95% R.H
	Staging	+25 to +45° C	20-80% R.H.
	Deployment	+2 to +45° C	20-40% R.H.
	Operational (DARS only)	+2 to +10° C	20-40% R.H.
	Operational (DTU only)	+2 to 60° C	0% R.H.

SOH Surface Communicator: Transmit BIP and BPP State-of-Health (SOH) status messages for 18 hours to the surface ship during BPP deployment and the initial ocean bottom operational configuration.

- EG&G Sealink Responder Model 321 and Shipboard Receiver
- Acoustic Coded Message (10 kHz, 2 bits/sec)
- Self-contained Batteries

Mechanical:

- Ocean Bottom Seismometer (OBS) Spheres (3 each, one for electronics, two for batteries)
- Sled, 8 ft W x 8 ft D x 7 ft H (Approximately)
- Total BPP Air Weight 8,500 lbs; BPP Water Weight 2,500 lbs.

3.0 GOULD EQUIPMENT SYSTEM DESCRIPTION

The MSS electronics supplied by Gould consist of the following major assemblies:

BIP Configured Equipment

- Data Transceiver Unit (DTU)

BPP Configured Equipment

- Bottom Processing Package (BPP) sled, spheres and mechanical assemblies;
- DARS containing the Data Input Assembly (DIA), Data Storage Controller (DSC), and the Data Storage Assembly (DSA); see Appendix A, photographs A-6 and A-7
- Hydroacoustic assembly located on the BPP;
- State-of-Health (SOH) communicator assembly located on the BPP and
- Two silver - zinc battery packs located within two spheres on the BPP. See Appendix A, photograph A-5.

An MSS equipment drawing package is available for the above mentioned Gould equipment.

3.1 BIP Configured Equipment

3.1.1 Data Transceiver Unit (DTU) Component

The DTU is located within BIP pressure vessel (Figure 3-1) and served as a seismic signal digitizer and a communications interface between the BIP electronics and the coax cable. It used FM/FSK communications for transmitting BIP status and seven data channels.

Board types, as shown in Figure 3-2 include:

- Switching Mode. Decoupled dc power from the shielding of the coax cable to power electronics within each bay;
- BIP Status/SOH. Provided the functions of BIP status/SOH transmission and EDME CAL generation. Four byte BIP status messages were transmitted asynchronously to the DARS at 300 baud with 16-bit CRC protection.

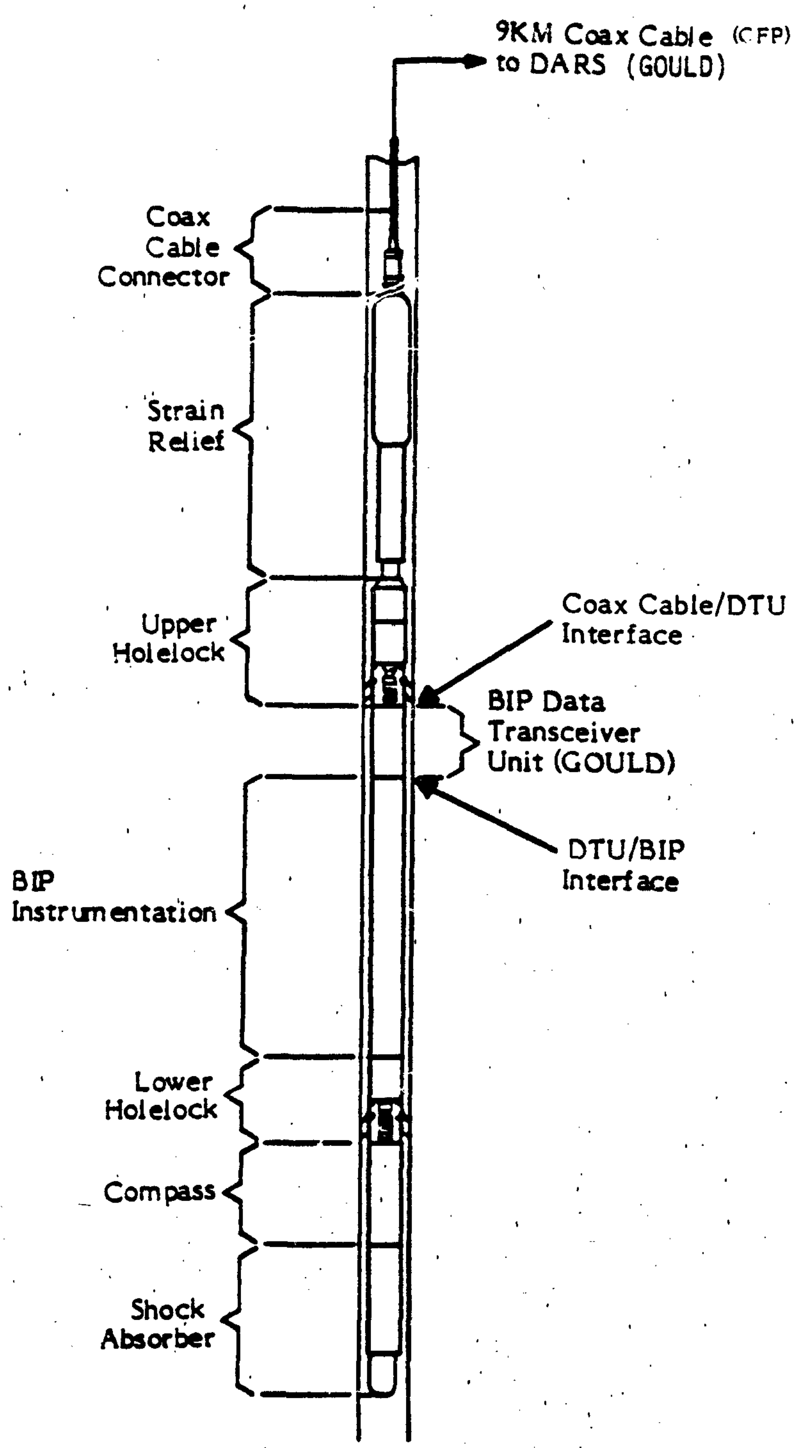
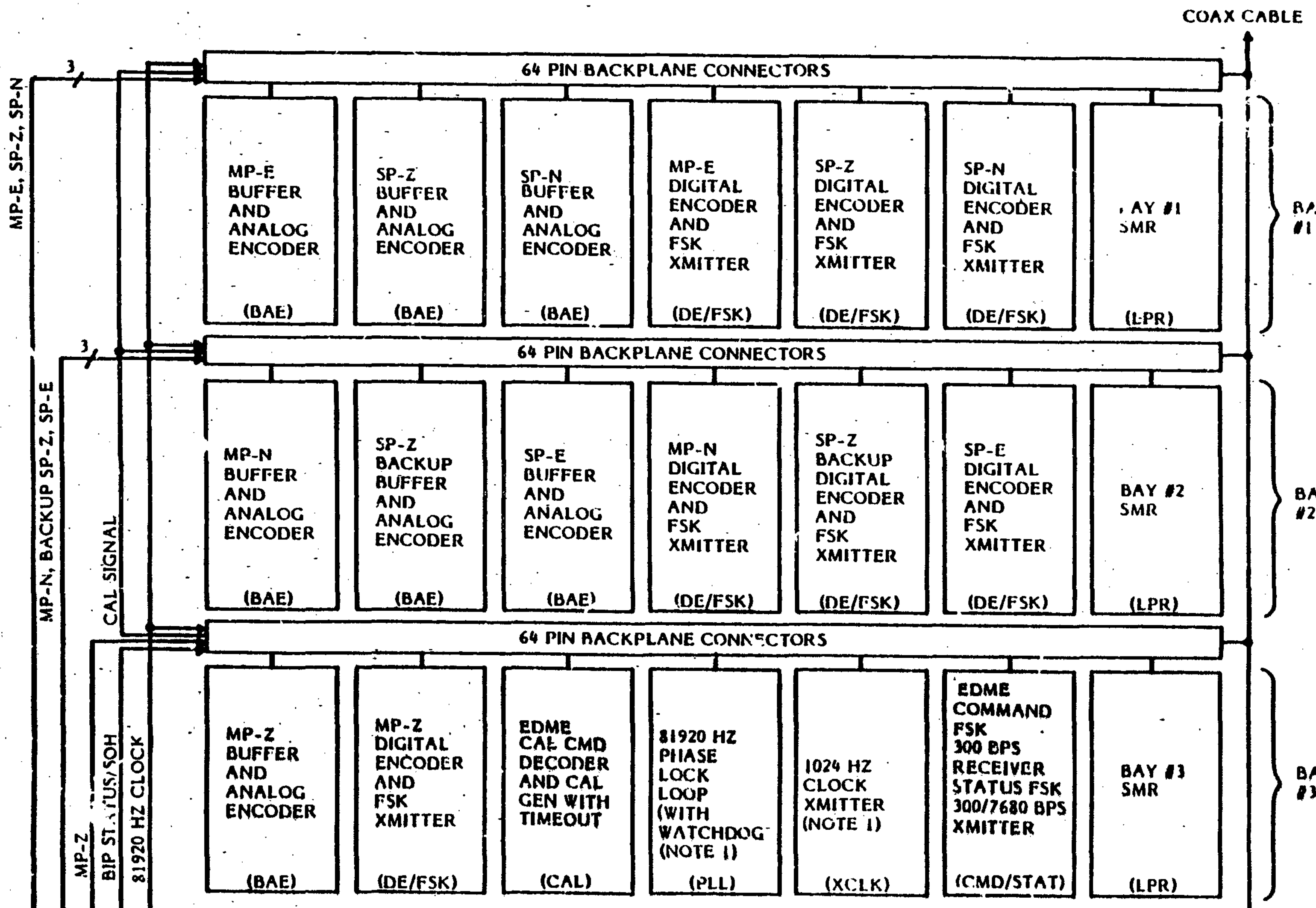


Figure 3-1. BIP Data Transceiver Unit (DTU) Configuration within the GEOTECH Model 53100 BIP



NOTE 1 - Phase Lock Loop and 1024 Hz clock transmitter boards are redundantly powered by the Bay 2 and Bay 3 SMRs.

Figure 3-2. BIP Data Transceiver Partitioning

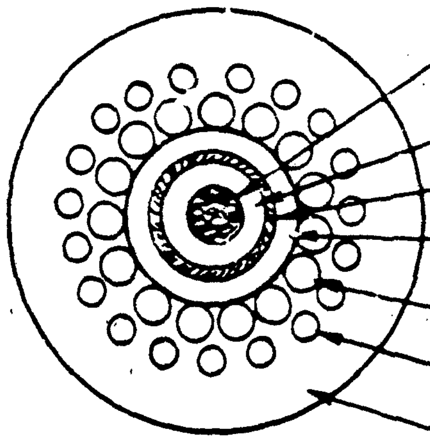
The BIP command channel was used for control of DTU electronic and BIP sensor calibrations. For an EDME calibration, the DARS transmitted an "AA" Hex pattern sync code for one-second to the DTU, which initiated a ten second EDME calibration via a CAL enable control line. The DTU CAL generation logic provided a failsafe timeout to terminate the EDME CAL. BIP sensor commands, executed by the Geotech BIP electronics, consisted of a three byte command format.

- EDME Encoders/FSK Transmitters. Seven EDMEs were used to encode the MP-Z, MP-N, and MP-E analog channels at 1.024 Kbps with the SP-Z, SP-N, SP-E, and backup SP-Z analog channels at 10.24 Kbps. A unique FSK frequency pair was assigned to each channel and used to transmit all data from the DTU to the DARS.
- EDME Telemetry Clock Receiver. A clock signal, synchronous with the system clock was provided on the coax cable. This signal was used to provide the 8.192/81.92 Kbps clock rates to the EDMEs and supply a 81.92 kHz clock to the BIP calibration generation circuits.

3.1.2 FM/FSK Telemetry Communication Link

The MSS FM/FSK Telemetry communication link consisted of FSK transmitters and receivers located within the DTU and DARS assemblies respectively connected by the 9 km EM coaxial cable (Figure 3-3). Table 3-1 defines the cable frequency allocations used to transmit power, seismic data, clocks, commands and status. The following describes each portion of the telemetry system.

- Power. The DARS power decoupler transferred the DC 130 volt power on the coaxial cable to the BIP and H/A electronics;
- Telemetry Clock. The DARS transferred a 81920 Hz sine wave from its master clock to the DTU for SP/MP EDME clock input and a 40960 Hz symmetrical square wave to the BIP seismometer electronics;



ELECTRICAL:	NOM CONDUCTOR DC RESISTANCE @ 20° C: @10 AWG:	1.08 OHMS/KFT
	COAX RETURN BRAID:	1.40 OHMS/KFT
	VOLTAGE RATING:	2,500 VOLTS RMS
	CHARACTERISTIC IMPENDANCE:	40 OHMS (REF)
	ATTENUATION AT 500 KC:	1.4 DB/KFT
MECHANICAL:	FILLED SHIELD:	TEMPLUBE BLKNG COMPOUND
	BREAK STRENGTH:	21,000 LBS
	WEIGHT IN AIR:	462 LBS/KFT
	WEIGHT IN WATER (SG = 1.027)	295 LBS/KFT
	TORQUE BALANCED DESIGN	
	LENGTH	9 KM

Figure 3-3. MSS Electrical/Mechanical (EM) Cable

Table 3-1

FSK Channel Pair Allocations

CHANNEL	BAUD RATE	FREQUENCY (HZ) f_0 (Space)	FREQUENCY (HZ) f_1 (Mark)
Data Rate Clock	1024	(1024 Hz Sine Wave)	
BIP Command(1)	300	2600	3100
MP-Z	1024	8000	9024
MP-N	1024	12024	13048
MP-E	1024	16048	17072
Power Switching(1) Frequency Range	20-25kHz (Amp = 0.3	microvolt peak-to-peak)	
BIP Status(2)	300	26000	33680
SP-Z	10240	45000	55240
Telemetry Clock(1)	81920	(81920 Hz sine wave)	
SP-Z Backup	10240	107480	117720
SP-N	10240	142720	152960
SP-E	10240	179880	190120

NOTE: 1) BIP Command, Power and Telemetry Clock is received by the DTU; whereas the Data Rate Clock, MP-Z,N,E,BIP status and SP-ZB,Z,N,E is transmitted by the DTU.

2) BIP Status Frequency allows 300 (operational) to 7680 (dual recording) baud rates.

- BIP Command. The DARS transferred, at a 300 baud rate, formatted BIP sensor calibration commands or a fixed bit pattern to enable the EDME calibration circuit for ten seconds;
- Data Rate Clock. A 1024 Hz sine wave was sent by the DTU to allow the DARS to synchronize the reception of 1024 bps MP and 10,240 bps SP data streams;
- BIP Status. A formatted message sent by the BIP consisting of two message sync bytes, four status bytes, and two CRC message protection bytes;
- Seismic Data Channels. Each data channel was assigned a frequency pair for transmitting 1024 bps MP or 10240 bps SP seismic serial data streams. Note, the DTU always transmitted the primary and backup SP channels; whereas, the DARS was configured at deployment time to receive only one of these two channels, and that was to allow the recording of the best SP-Z channel data.

3.2 BPP Configured Equipment

3.2.1 BPP Sled-Mechanical Components

Gould, DED fabricated the BPP sled to Naval Civil Engineering Laboratory (NCEL) supplied specifications and drawings.

The Bottom Processing Package consisted of three aluminum spheres, (GFP supplied by NORDA), mounted on an all aluminum platform structure which provided the means of terminating the electro-mechanical coaxial cable, the mooring riser line and retrieval hardware as shown in Figure 3-4. The total BPP assembly weighed approximately 4536 kilograms in air with an estimated water weight of 1134 kilograms. Its outside dimensions were approximately 254 cm x 249 cm x 224 cm (LxWxH). The entire sled structure was fabricated from 6061, T6 aluminum. The three spheres were used to house the DARS electronics, and the two battery packs. Each sphere was constructed

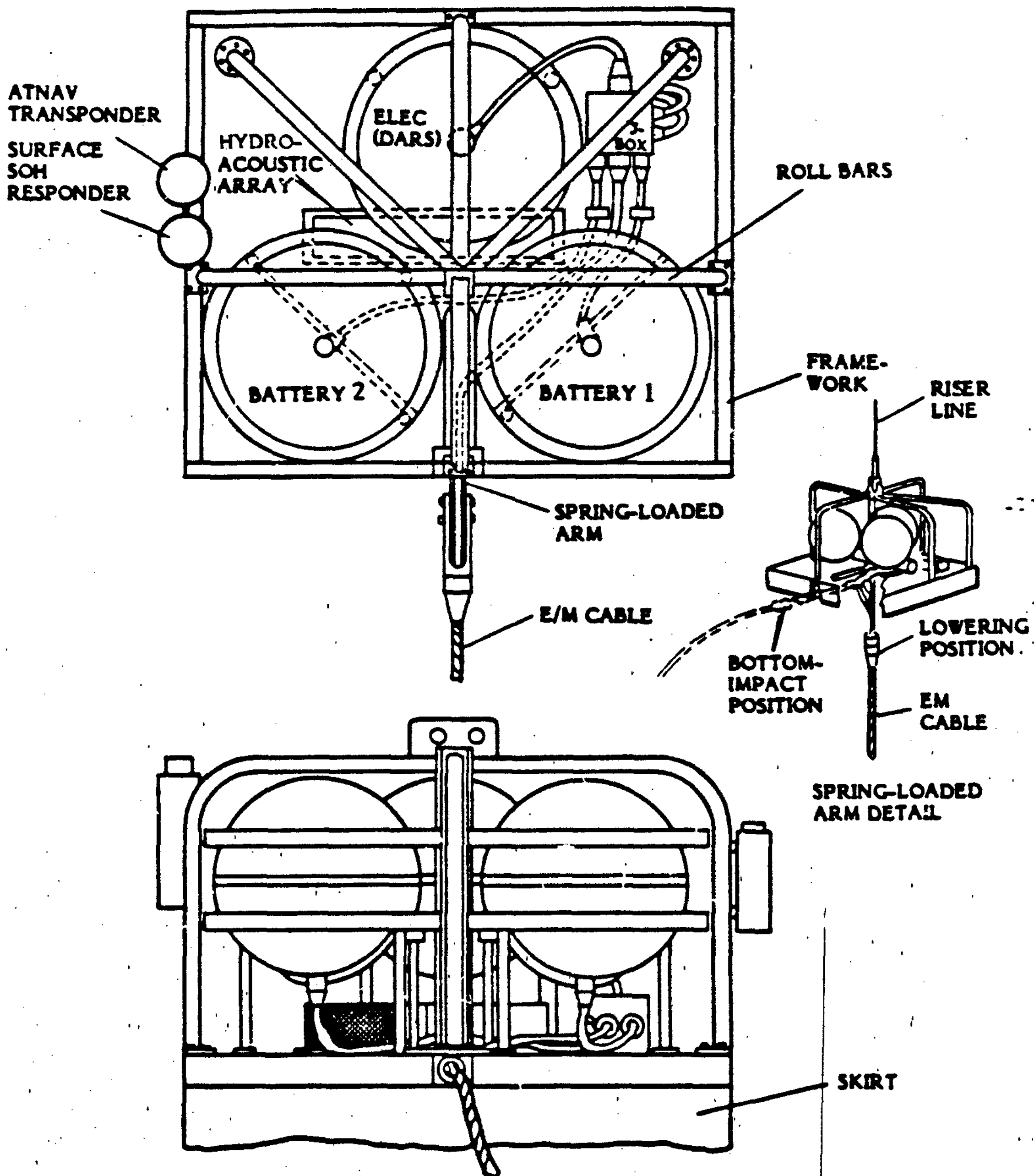


Figure 3-4. MSS - Bottom Processing Package - Mechanical Configuration

from 7078 aluminum; each had an inside diameter of 92.7 cm on the vertical axis and 85.1 cm on the horizontal axis; a wall thickness of 5.08 cm; an outside diameter of 102.9 cm and weighed approximately 485 kilograms in air.

Also included on the BPP sled was an ATNAV Transponder which was used for locating the BPP sled during recovery operations, a hydroacoustic sensor assembly, a cable junction box, surface SOH responder, and spring-loaded EM cable arm.

3.2.2 Data Acquisition and Recording System (DARS)

The DARS electronics, as functionally diagrammed in Figure 3-5 and shown in Appendix A, photograph A-3, was located within a single sphere on the BPP. It consisted of three major assemblies:

3.2.2.1 Data Input Assembly (DIA)

The DIA provided a communication interface between the DTU and the Data Storage Controller (DSC). The following specific functions were performed by the DIA:

- FSK Demodulation - A Frequency Shift Keyed (FSK) demodulator was provided for each of the seven data channels in the BIP, with an FSK modem was provided for the BIP command/status channel.
- Finite Impulse Response (FIR) Filters - Two, multi-channel FIR filters were implemented to bandpass limit, decimate, and convert the serial bit stream output of the SP/MP EDMEs into 24 bit, 2's complement integer samples. The MP FIR filter outputted 4 samples per second for each of the three mid-period data channels. The SP FIR filter outputted 40 samples per second for each of the three short-period data channels and the hydroacoustic channel (the hydroacoustic data output was 16 bit, 2's complement integer samples). Note that only one of the two short-period vertical seismic channels was acquired and processed by the DIA (i.e., the selection as to which short-period vertical channel to be processed was hardwired into the system prior to deployment).

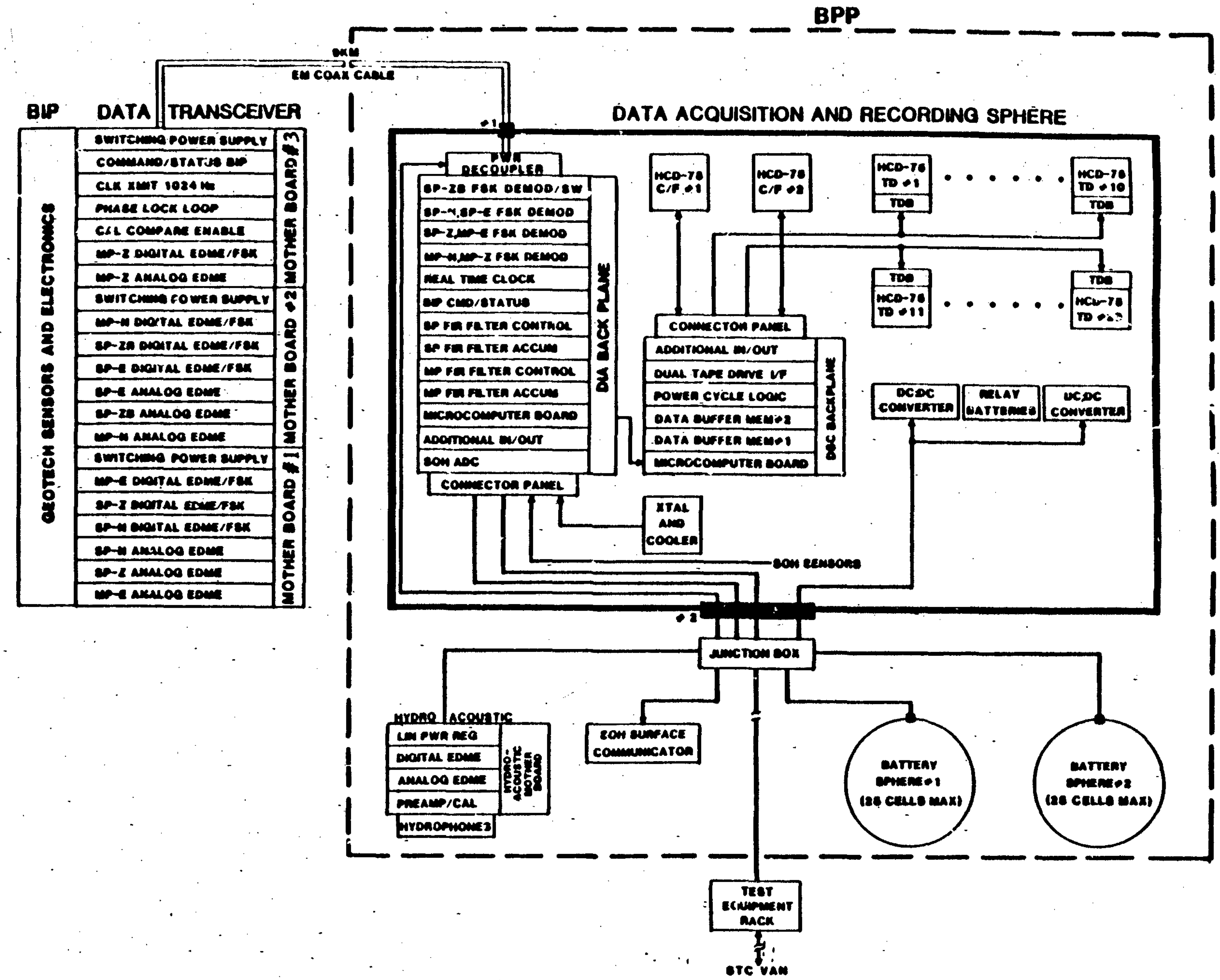


Figure 3-5. MSS - Data Acquisition and Recording Sphere and Interfacing Equipment

- Real Time Clock (RTC) - The system clock was derived from a cut crystal (6.5536 MHz) which had a stability of better than 1×10^{-9} when operating at a temperature of 1.5° C. All of the system timing pulses were derived from this crystal. RTC time synchronization to WWV was accomplished prior to deployment on the shipboard deck. The RTC maintained a 1 Hz time pulse synchronous to WWV at a nominal +/- 20 milliseconds over the 45 day ocean bottom operation. As shown in Figure 3-6, various clocks were generated by the RTC clock board using the master 6.5536 mHz crystal for use in the DTU, DIA, and DSC timing operations.

- DARS State-Of-Health (SOH) Monitor - An 8 bit Analog-to-Digital Converter (ADC) and a 32 channel analog multiplexer provided the means of acquiring and monitoring the BPP SOH. The following SOH inputs were monitored; three leak detectors (one per sphere), two orthogonal tilt sensors, one pressure transducer, eight voltage monitors, and two ADC status monitors.

- BIP Command and Status - Single frequency and full frequency calibration commands were transmitted to the BIP. BIP SOH/status were transmitted to the DIA via separate FSK communication channels.

- SOH Communications - The DIA interfaced with an EG&G Sealink model 321 responder and was used to communicate the DARS SOH to the surface ship during the deployment of the BPP. The responder operated at a carrier frequency of 10.0 kHz. A 13 or 26 bit status message was transmitted once every 120 seconds, at a two bit per second rate for the first 18 hours of BPP operation.

- DIA Microcomputer - The microcomputer and additional input/output boards acquired all data (i.e., MP/SP seismic data, hydroacoustic data, BIP status, and DARS SOH); added WWV time to the data buffers and continuously

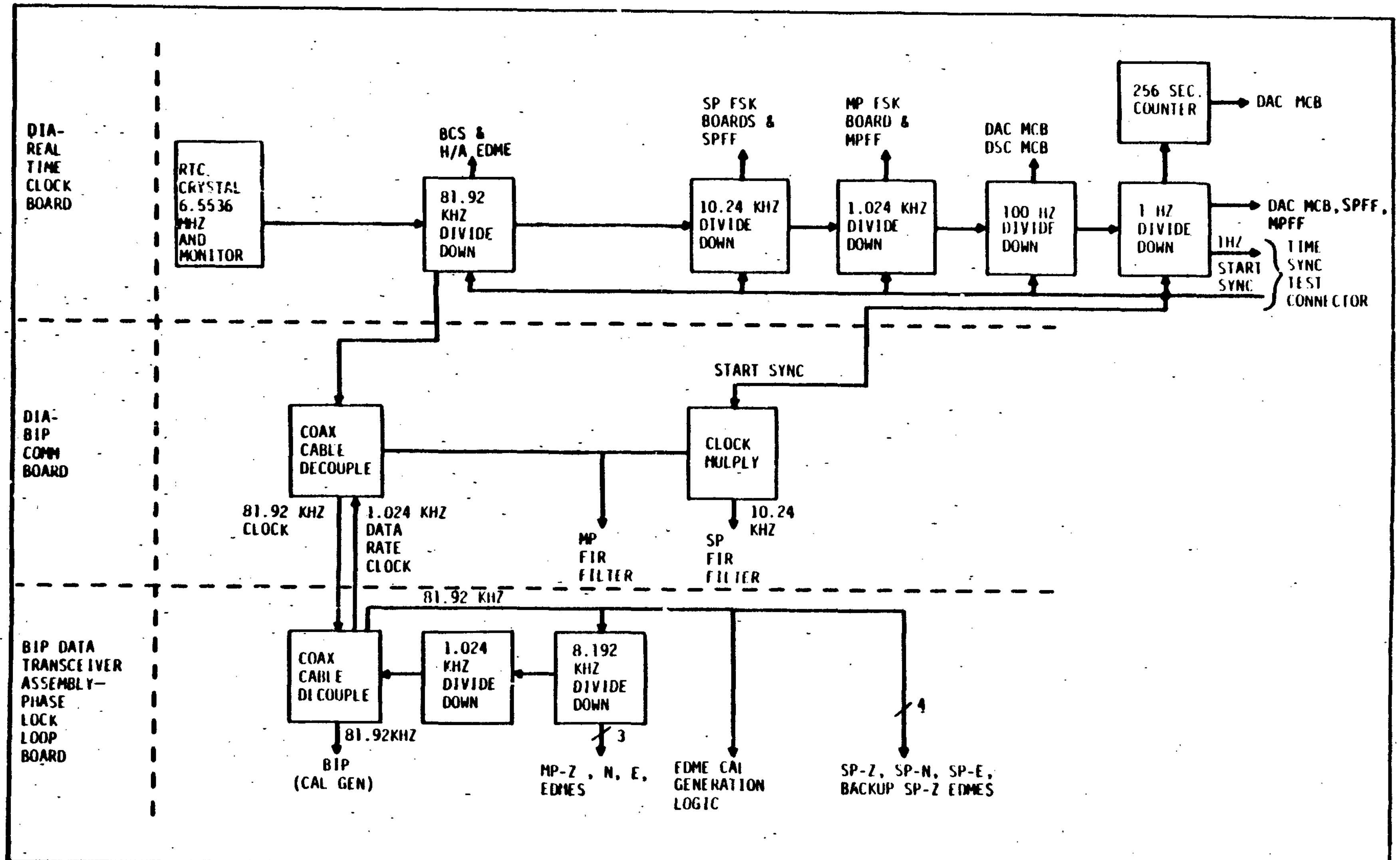


Figure 3-6. DARS System Timing Diagram

transferred one second data blocks (time and data) to the DSC via a serial link. This board also formatted and transmitted single and full frequency calibration command messages to the BIP.

3.2.2.2 Data Storage Controller (DSC)

The DSC's primary function was to acquire the 1 second buffers from the DIA; format and buffer the data prior to recording; and provide the control and data transfer to the Data Storage Assembly (DSA). The DARS electronics as shown in Figure 3-5, contain the DSC assembly with data buffer memory which consisted of two 64 kbytes Random Access Memory (RAM) boards with 4 bit Hamming code error detection/correction. The 128 kbytes of buffer memory was used to store the 1 second data buffers from the DIA prior to recording. The purpose of the buffer was to minimize the power dissipation of the DSA and allow for tape drive initialization. The DSC also formatted the data prior to storage in the buffer memory. Data storage formats are shown in Table 3-2.

Table 3-2

One Second DIA to DAC Block Format

45 Days	256 SECOND COUNTER BYTE		SECONDS (Tens 0-5)	SECONDS (Units 0-9)	MINUTES (Tens 0-5)	MINUTES (Units 0-9)
	Hours (Tens 0-2)	Hours (Units 9-9)	Days (Binary 0-255)		DAC Status BYTE	
	SOH ID NO. BYTE		SOH SAMPLE (16 BIT)			
	SP-Z		SAMPLE 1		(24 BIT)	
	SP-Z		SAMPLE 40		(24 BIT)	
	MP-Z		SAMPLE 1		(24 BIT)	
	MP-N		SAMPLE 1		(24 BIT)	
	MP-E		SAMPLE 1		(24 BIT)	
	MP-Z		SAMPLE 4		(24 BIT)	
	MP-N		SAMPLE 4		(24 BIT)	
	MP-E		SAMPLE 4		(24 BIT)	
First 30 days only	HYDROACOUSTIC		SAMPLE 1		(16 BIT)	
	HYDROACOUSTIC		SAMPLE 40		(16 BIT)	
First 22 days only	SP-N		SAMPLE 1		(24 BIT)	
	SP-N		SAMPLE 40		(24 BIT)	
	SP-E		SAMPLE 1		(24 BIT)	
	SP-E		SAMPLE 40		(24 BIT)	

They were designed to be used as follows:

- First 22 days - All data channels are buffered and recorded (269 seconds of data at 485 bytes/second buffered prior to recording);
- Next 8 days - The two short-period horizontal data channels deleted from the buffer and recording (533 seconds of data at 245 bytes/second buffered prior to recording); and
- Next 15 days - In addition to the two short-period horizontal channels, the hydroacoustic channel also deleted from the buffer, (791 seconds of data at 165 bytes/second buffered prior to recording).

3.2.2.3 Data Storage Assembly (DSA)

The DSA consisted of two 3M HCD-75 controller/formatters and twenty 3M HCD-75 high-density cartridge tape drives. The following is a summary of the DSA characteristics:

- All tape drives utilized a 182.88 meter, 0.635 cm formatted digital cartridge tape;
- Each cartridge tape consisted of 16 tracks, 4096 blocks per track, 1024 bytes per block, for a total of 65,536 blocks or 67.1 million bytes of user data storage;
- Two redundant controller/formatters were capable of addressing any one of the twenty tape drives;
- 1024 byte transfer at 17.5 kbytes/second (approximately 58.5 milliseconds per block transfer);
- Typical write time was 8 seconds for the 128 kbytes buffer memory; and
- Depending upon data format, there was to be 38.2, 75.7, or 112.3 hours of data per cartridge.

3.2.3 Hydroacoustic Assembly

The hydroacoustic assembly, as shown in Figures 3-4 (top view) and 3-5 (functionally), was located on the BPP sled between the DARS electronics and battery spheres.

This assembly consisted of 1) four hydrophones, 2) one sensor mount, 3) one pressure vessel connector, 4) one preamplifier, 5) one EDME and calibration signal generation electronics, 6) power regulator, 7) sensor package termination, 8) cable between the sensor and pressure vessel, 9) pressure vessel termination, and 10) electronics pressure vessel. Power supply and calibration control were provided from the DARS electronics with the hydroacoustic calibration signal generation provided within the hydroacoustic sensor electronics.

3.2.4 State-of-Health (SOH) Communications

An EG&G Sealink model 321 responder was used to communicate system status to the surface ship during BPP deployment and operation. BIP/BPP status was communicated during the first 18 hours of the 45 day mission to indicate current system go/no go status, SOH changes and operational status changes; such as, calibration in progress, switching from tape drive #1 to #2, etc. A parity protected status byte and, SOH byte value was transmitted once every 120 seconds to the surface ship to provide MSS system operational visibility.

3.2.5 Battery Power Subsystem

The BIP/DARS electronics primary power was provided by two silver-zinc batteries, Yardney part number 16950. Each battery was made of 25 PML 2500 cells, connected in series and had a minimum capacity of 2500 ampere-hours, at a nominal 38.75 voltage load. The two batteries were connected in parallel, resulting in a total minimum capacity of 5000 ampere-hours. The dimensions of each battery were 63.65 cm x 63.65 cm square by 54.61 cm high with a weight of 470.7 kilograms.

With the exception of the SOH Communicator having its own battery power supply and a +12 V battery supplying surge relay power to the HCD-75 tape drives, all BIP sensors, the DTU, the hydroacoustic assembly, and the DARS electronics were powered by the two silver-zinc batteries.

4.0 GOULD EQUIPMENT SET-UP, TESTING AND OPERATION

Due to the complexity of the MSS electronics the following test and operational instructions must be performed by personnel with intimate knowledge of the system electronics and also the shipboard support electronics.

4.1 Shipboard Equipment Description

The following list of equipment defines each item and describes its use when preparing the BPP for deployment.

4.1.1 Shipboard Portable Instrumentation Van

This van was used to house the electronic support equipment and personnel during MSS deployment operations. The MSS equipment was placed in the casing rack aboard the Challenger; therefore, the van protected the equipment and personnel from the environment. See Appendix A, photograph A-2. A complete description and specification of the van is continued in Appendix C.

4.1.2 Electronic Support Equipment

The Test Equipment Rack (TER) was used to configure the following equipment. (Refer to Figure 4-1.)

- The Surface Communicator Receiver, EG&G Model 200, was used in conjunction with a hydrophone placed over the side of the ship beneath the hull to receive acoustic SOH signals transmitted from the BPP by the surface communicator responder. The output signals from the receiver were filtered by the test connector interface unit and fed to the Mostek microcomputer for processing and display on the Mostek line printer;
- The Shipboard Cartridge Recorder contained two HCD-75 tape drives and one HCD-75 controller formatter. This unit was used to record data collected by the BPP or the spare data input assembly. All shipboard recordings made during the deployment were made on this unit;

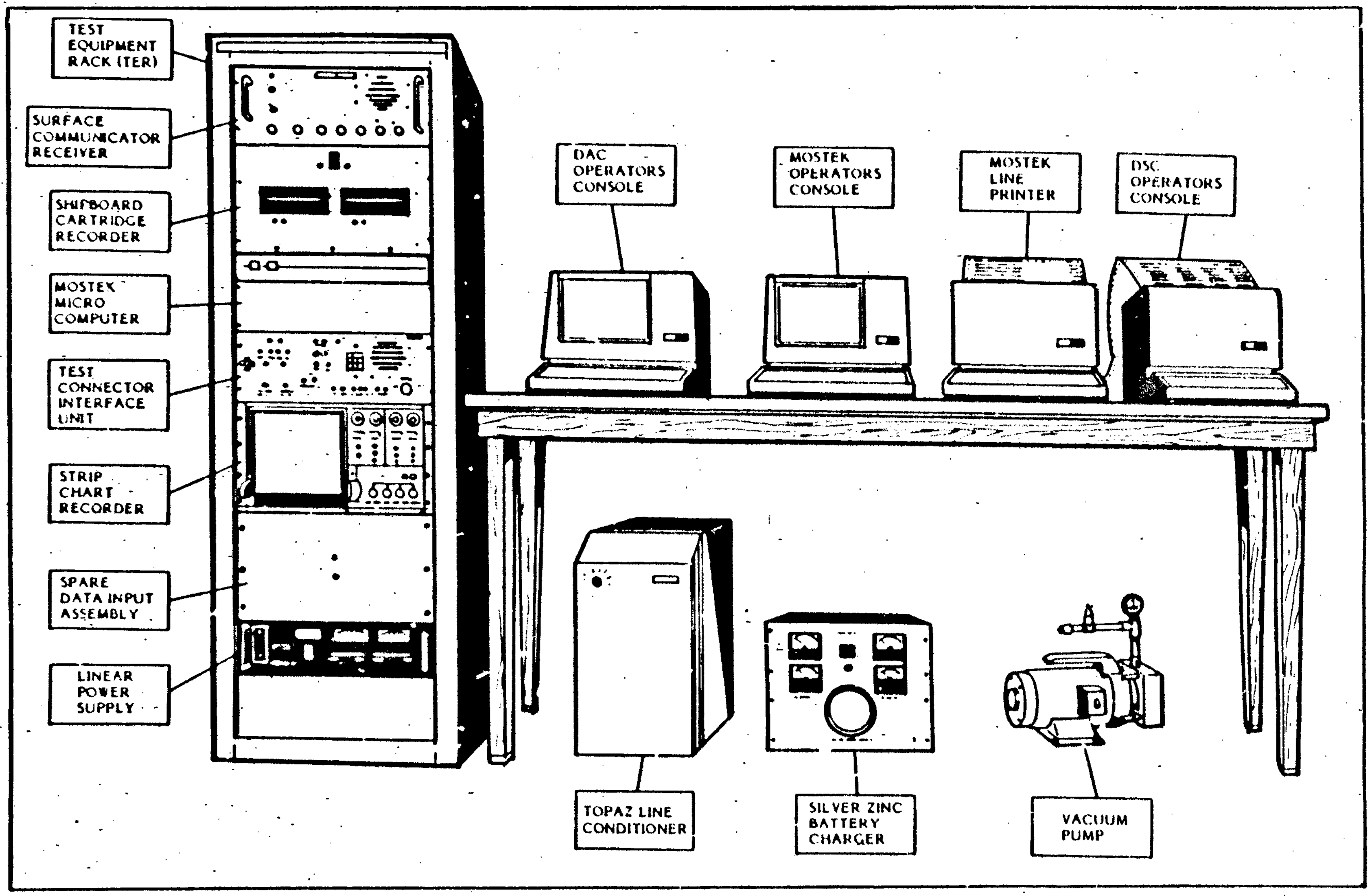


Figure 4-1. Test Equipment Rack

- The Mostek Micro-Computer was a Z80 based micro-processor used to collect and process data to be recorded on the shipboard recording system. Data input was provided from either the BPP or the spare data input assembly as determined by the operation. Other functions included 1) single channel digital to analog conversion for display analog seismic signals on the strip chart recorder, 2) process and display of BPP surface communicator SOH messages. The firmware was also capable of performing a limited FFT (Fast Fourier Transform) on seismic or hydroacoustic data recorded on the shipboard cartridge recorder;

- The Test Connector Interface Unit housed the following functions:

  1. Patch panel for all cable interfaces to the BPP junction box, with exception of the silver zinc battery charger; see Appendix A, photograph A-4.
  2. Relay battery charge circuits to charge the nickel cadmium relay batteries (tape drive relay batteries) located within the DARS pressure vessel;
  3. Operator console interface to the DAC, DSC, and Mostek;
  4. Selection switches for the BIP SP-Z or SP-Z BACKUP (Z or ZB to be recorded on tape or displayed on the strip chart recorder);
  5. WWV synchronization circuits used to set the BPP clock to WWV and to monitor both clocks and measure drift. Also, it contained a speaker to listen to the audio portion of the WWV transmission received by the ships WWV receiver;
  6. System master reset control to initialize the DARS electronics; and
  7. BPP power relay controls used to operate power relay within the DARS pressure vessel;

- The Strip Chart Recorder (model HP7404A with four model HP 17402A pre-amp units) was used to display the analog signals produced by the Mostek Micro-Computers digital to analog converter;
- The Spare Data Input Assembly contained a full complement of spare DIA Printed Wire Assemblies (PWAs) and was capable of emulating the BPP's DIA. It was used for BIP checkout and testing as well as BPP testing;
- The Linear Power Supply was used to supply dc power to the BPP in place of the silver zinc batteries;
- The Topaz Line Conditioner, Model 61010-01, was used to filter line transients produced by the ship's generators;
- The DAC Operators Console, DEC Model VT131, allowed the operator to communicate with the data acquisition controllers Z80 micro-computer;
- The DSC Operators Console, DEC Model LA34, allowed the operator to communicate with the data storage controllers Z80 micro-computer;
- The Mostek Operators Console, DEC Model VT131, allowed the operator to communicate with the Mostek's Z80 micro-computer;
- The Mostek Line Printer, DEC Model LA34, was used to produce hard copy records of tests performed and also recorded SOH surface communication messages during deployment of the BPP;
- The Silver Zinc Battery Charger was used to booster charge the two BPP batteries located within their respective pressure vessels; and
- Miscellaneous electronic test equipment such as oscilloscope, spectrum analyzer power supplies, DVM, etc. were also used for system testing during the deployment operations.

4.1.3 Mechanical Support Equipment

- The vacuum pump was used to evacuate the pressure vessels prior to BPP deployment and thus seal the upper and lower hemispheres to the hemisphere ring;

- A chain hoist was needed to lift the top hemispheres from the pressure vessels;
- Miscellaneous mechanics tools were required to disassemble and assemble the BPP;
- Miscellaneous engineering laboratory equipment such as soldering irons, cleaning solvents, drop lights, etc. were required to maintain the operational equipment; and
- Miscellaneous spare hardware such as PWAs, tape drives, integrated circuits, etc. were required for repair and maintenance of the operational equipment.

4.2 DTU Setup, Testing and Operation

As described in Section 2.0, the Data Transceiver Unit (DTU) was a component within the Borehole Instrumentation Package (BIP). The DTU was used to:

- Digitize the analog SP-Z, N, E, and backup SP-Z data channel;
- Digitize the analog MP-Z, N, and E data channels;
- Provide commanding of EDME and BIP sensor calibration;
- Transmit BIP status messages to the BPP; and
- Transmit all seismic data to the BPP.

DTU setup, testing and operation activities included 1) interface testing at Geotech facilities, 2) warehouse staging prior to Glomar Challenger deployment, and 3) DTU deployment and operational testing.

4.2.1 Interface Testing at Teledyne Geotech Facilities

Assembly, component interfacing and system level tests were conducted at Gould, DED (Glen Burnie, MD) and Teledyne Geotech (Dallas, TX) to verify DTU system performance prior to shipment in support of the MSS '82 and '83 deployments. Typical tests included the following:

- Digitized and transferred data streams and clock frequencies over 6400 ft of coax cable (Gould facility),

- Tested the DTU in conjunction with Data Input Assembly (DIA) telemetry receiver and FIR filter boards,
- Injected sinewaves from Low-Distortion Oscillator (LDO) test assemblies into the DTU and performed Fast-Fourier Transform (FFT) analysis,
- Performed EDME calibration command tests,
- Repeated above DTU tests using DIA assembly,
- Measured typical/maximum power requirements for the DTU,
- Verified all mechanical, electrical and data interfaces between the BIP and DTU assemblies,
- Full system test of DTU with LDO analog signal input, and
- DTU equipment burn-in (Geotech Facility).

4.2.2 Warehouse Staging Prior to Glomar Challenger Deployment

Once all the MSS equipment arrived at the staging area, the full set of functional and system tests as described above were performed. Since a backup BIP was deployed, this included testing two DTUs, i.e., DTU #1 located in BIP #1 and DTU #2 located in BIP #2. It should be noted that the BIP was to be a sealed unit upon leaving Texas and not to be opened during staging or deployment. Therefore full function board level testing was not planned. The BIP was however opened for testing at staging.

Typical functions tested included:

- Fourteen second EDME calibration test in each DTU to verify each channel's performance (analog display),
- Command/status interface verification with respect to BIP components,
- Power supplied via EM cable was decoupled properly by the BIP and DTU components,
- Data from all channels was being sampled synchronously, and
- Performance analysis of all channels by injecting a known Low Distortion Oscillator signal and performing an FFT to verify each channel's performance.

Once the DTU and BIP components were verified at the warehouse staging area, they are sealed within the deployment container and loaded aboard the Glomar Challenger.

4.2.3 DTU Deployment and Operational Testing

With the DTU sealed within the BIP casing, the S750 sensors provide the only analog signal input; therefore, only limited DTU testing could be performed aboard ship prior to BIP deployment. This limited testing included:

- Verification of FSK frequency alignment for each channel on the EM cable;
- BIP status, temperature, and voltage checks; and
- EDME calibration checks for each channel.

During deployment/installation checkout of the BIP (reference Section 2.1), the DTU component was deactivated. During that period Teledyne Geotech's STC was used to monitor BIP status and verify BIP sensor performance (Figure 2-2). With the BIP installed in the borehole, the dry end of the EM cable was shared between the Geotech STC van to the Gould BPP sled (Figure 2-3). As shown in Figure 4-2, the DTU was then configured in the test mode with the BPP where the Gould TER was used to acquire and record data from the BIP/DTU/BPP (Figure 2-4). The BPP Data Acquisition and Recording System (DARS) electronics were configured to execute the MSS operation program which allowed for the acquisition of BIP seismic sensor data, BIP status messages, and for the transmission of calibration commands to the BIP.

DTU operational testing executed prior to parallel recording of BIP data included:

- BIP status message verification;
- EDME calibration and verification of each data channel's performance via a strip chart recorder;
- Single and full frequency BIP calibration to verify each data channel via a strip chart recorder; and
- Seismic data acquisition from each channel and performance of FFT analysis.

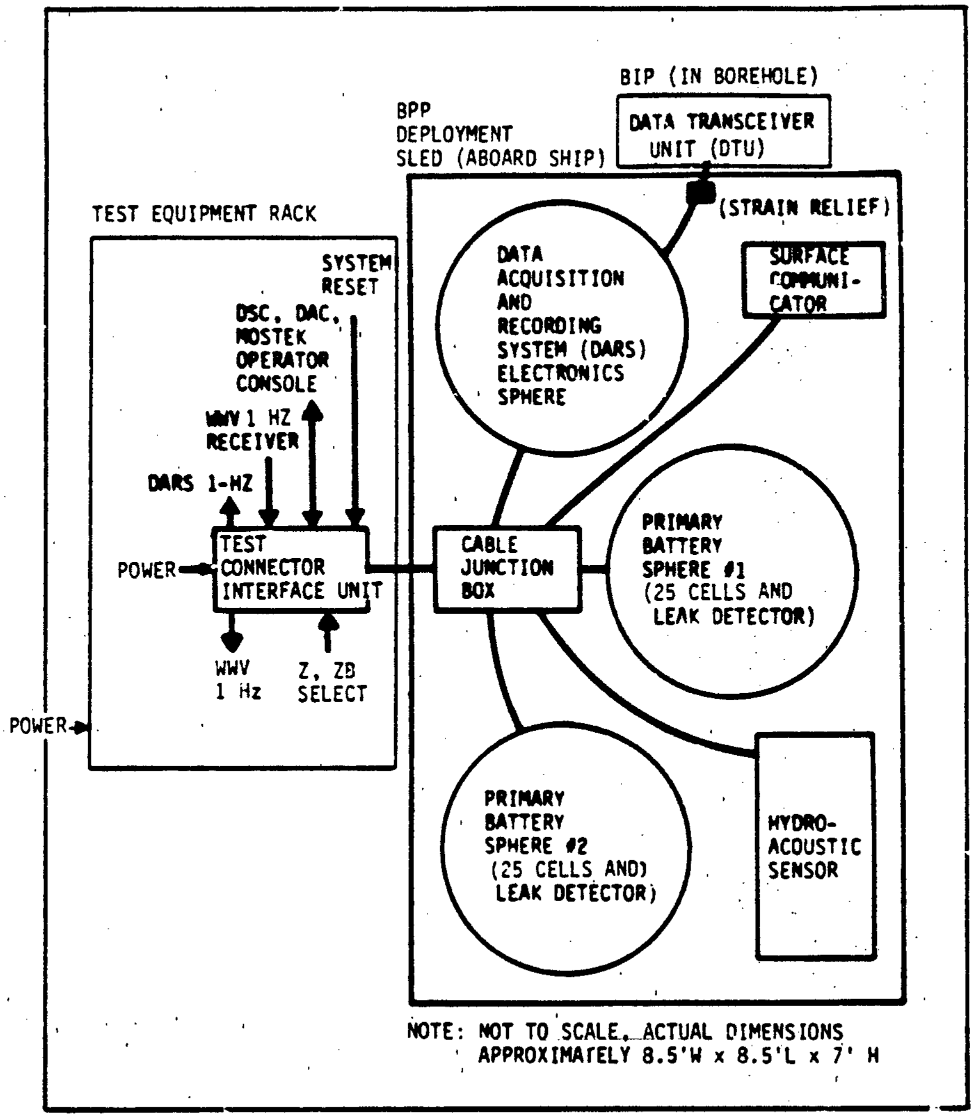


Figure 4-2. MSS/1983 BPP Pre-Deployment Shipboard Test Mode Configuration (Top View)

4.3 BPP Set-Up, Testing, and Operation

4.3.1 Dockside Staging

Upon receipt of the equipment, at the staging facility, a complete visual inspection was performed in order to assess damage which might have occurred during shipping.

The BPP was then readied for deployment by testing the DARS electronics, hydroacoustic assembly and surface communicator. The Silver Zinc battery packs were prepared by the addition of potassium hydroxide to the cells and the subsequent soaking period. See Appendix A, photograph A-1. A 24 hour per day watch was maintained to ensure no internal battery shorts had occurred during shipping. This watch was maintained for 72 hours with periodic checks made up until the BPP was deployed. Refer to Appendix B for the Yardney operating instruction for silver cell batteries. See Section 5.1 for a summary of battery failure problems.

4.3.2 Shipboard Activities

When the equipment was loaded aboard the ship, all ships services were connected (i.e., power, voice communications, and special cabling). Ship's power was carefully checked to ensure proper voltage and current capabilities were obtained.

The instructions contained in Sections 4.3.2.1, 4.3.2.2 and 4.3.2.3 were used aboard the challenger to verify the operation of the BPP. We present these procedures here as they might be used on future MSS deployments. All page number callouts contained in this section are to be referenced to Appendix D entitled "MSS User Manual, 23 December 1982, Revision B."

Power up all equipment and reset both the DARS electronics and the Mostek microcomputer.

4.3.2.1 BPP Electronics Verification Mode (Prior to BIP Deployment)

Data Storage Assembly (DSA)

All HCD-75 tape cartridges must be formatted and verified. This operation informs the HCD-75 controller of the condi[illegible] the cartridge and stores a skip table

(Bad block table) on the cartridge itself. The skip table consists of tape block addresses, which are considered non-functioning. When the tape drive is powered up the controller reads the skip table from tape and will not write data in those locations. Perform test called "HCD-75 EXERCISE/DIAGNOSTIC command [HCD] ". Refer to page 16 and 17 for details of this test. Continue this procedure until all tape drives have been tested.

Test the Data Buffer Memory (DBM) in the DSA by using the "TEST MEMORY COMMAND [T] ". Refer to page 32 for details of this test. If an error is consistently found, isolate the problem to one of the two DBM boards and replace it.

Hydroacoustic Assembly (H/A)

Establish communications between the DAC and the Mostek system by performing the [MOS] command, page 23.

Test the Hydroacoustic Assembly by displaying this channel of the strip chart recorder. Refer to page 29 for details of this test. Upon initiation of the display stimulate the hydrophone, on the H/A assembly, by poking it gently and observing the strip chart recorder for activity. Initiate a H/A calibration by use of the BIP command [BIP] on page 6. Observe the strip chart recorder for activity.

Data Acquisition Controller (DAC)

Test the DAC electronics as follows:

Perform a SOH display and observe the DAC operator console. Verify displayed data. Refer to page 30 for details of this test.

Establish communications between the DAC and the Mostek system by performing the [MOS] command on page 23.

Display all seismic channels, one at a time, on the strip chart recorder. Refer to page 29 for details of this test. Observe the ambient seismic information displayed on the strip chart recorder. While each channel is being displayed, initiate a full frequency calibration command, page 6, and observe the strip chart recorder for proper activity.

Test the surface communicator by initiating the [GO] command, page 14, and listen to the responder, mounted on the BPP, for pinging at an approximately one second rate.

4.3.2.2 Dual Recording Mode

The EM cable is connected to both the BPP and the Teledyne Geotech STC Van in parallel. The BIP receives its power from the BPP in this mode.

To initiate the dual recording mode of operation perform the following:

1. Reset both the Mostek system and the BPP,
2. Install known good tapes in the shipboard cartridge recorder,
3. Perform the [PUP] command, page 27, on the Mostek operator's console. PUP tape drive number 2 first then tape drive number 1,
4. Synchronize the BPP's clock to WWV using the test interface unit in the test equipment rack. Connect an oscilloscope to both the WWV and the DARS 1 Hz BNC jacks to monitor the two clock signals. Arm the WWV sync using the test interface unit. Observe the oscilloscope, both scope traces should coincide when synchronization occurs,
5. Set the BPP's real time clock to WWV by performing the [TIM] command on page 33. Julian time should be acquired by listening to the audio broadcast on the WWV receiver, and
6. Initiate the recordings by performing the [MOS] command on page 23.

> **NOTE**
>
> In the dual recording mode of operation the Teledyne Geotech STC Van has complete command control of the BIP.

4.3.2.3 BPP Deployment Mode

Prior to deployment all HCD-75 tape drives must place the tape cartridge to the End Of Tape (EOT) position. Perform the [EOT] command, page 11, in conjunction with the [PUP] command, page 27, until all 20 HCD-75 tape cartridges are placed at EOT.

Prior to deployment the BPP sled must be readied by evacuating the three pressure vessels using the vacuum pump. Each power pressure vessel should be evacuated to 1/3 of an atmosphere. The DARS pressure vessel must be evacuated to a specific absolute pressure so that the operating relative humidity is controlled to between 20% and 80%. All pressure cables must be checked to ensure a proper watertight seal.

The EM cable must be connected to the BPP, electrically and mechanically. Prior to deployment either the SP-Z or SP-ZB must be selected for recording. The SP-ZB was selected during the 1983 MSS deployment. Installation of the proper jumper plug in the junction box will make this selection. Connection of the battery packs must be made by installing a jumper plug in the junction box.

To initiate the deployment mode of operation perform the following:

1. Power up the BPP using the relay controls on the test interface unit,
2. Reset both the BPP and the Mostek system,
3. Place the surface communicator's receiving hydrophone in the water approximately 50 feet below the ship's hull,
4. Synchronize the BPP's clock to WWV using the test interface unit in the test equipment rack. Connect an oscilloscope to both the WWV and the DARS 1 Hz BNC jacks to monitor the two clock signals. Arm the WWV sync using the test interface unit. Observe the oscilloscope, both scope traces should coincide when synchronization occurs,
5. Set the BPP's real time clock to WWV by performing the [TIM] command on page 33. ZULU time should be acquired by listening to the audio broadcast on the WWV receiver,
6. Initialize the BIP by performing the [BIP G] command on page 6,
7. Initialize the BPP by performing the [GO] command on page 14,
8. Initialize the Mostek by performing the [GTM] command on page 15,
9. Remove the test cables from the junction box and install the connector pressure caps on the junction box.

NOTE

The surface communicator should remain pinging when the cables are removed. This is an indication that the BPP is operational.

10. When the BPP is placed in the water observe the Mostek's operator console for state-of-health messages from the BPP. This indicates that the system is operational on its way to the bottom. The messages will continue for 18 hours after the [GO] command is issued.

5.0 MSS SYSTEM DEPLOYMENTS AND RECOVERY

Two MSS deployment missions were supported by Gould. The first was an unsuccessful attempt during October and November, 1982 in the Northwest Pacific during Glomar Challenger Leg 88. The second was a successful deployment during January and February, 1983 in the South Pacific during Glomar Challenger Leg 91.

5.1 Leg 88/1982 Northwest Pacific Deployment Attempt

Glomar Challenger Leg 88, during the late Summer of 1982 was the first attempt to deploy the MSS DTU and BPP electronics. This deployment location (Site 581) in the oceanic crust off the Kuriles, was ideally suited to the MSS mission; however, due to drilling problems the deployment attempt was finally abandoned.

The Gould, DED MSS team and equipment were transported via Military Airlift Command (MAC) from Dover AFB, Delaware to Chotose Airport near Sapporo, Japan. The equipment was then offloaded and trucked to the MSS staging and mobilization area at the Hakodate Dock Yard in Hakodate, Japan.

During checkout of the BPP electronics at the staging area, one of the silver-zinc batteries "hot-shorted" and overheated until a meltdown occurred. The other 24 cells in the battery pack, the battery sphere, and associated sphere cabling absorbed much of the heat generated by the defective cell melt down and were damaged beyond use. The batteries had been dry shipped to Japan with the electrolyte installed at the staging area. Therefore there was no way to know of the hot short until the cells were filled during staging. Through a coordinated effort between Yardney, Gould, NORDA, commercial airlines and operational Navy ships, new silver-zinc cells were manufactured in record time and delivered to the Glomar Challenger at sea. The damaged batteries, sphere, and associated cabling were then replaced. The destroyed battery was sent to the U.S. Military Disposal Office in Misawa City, Japan. Reference paragraph 6.1.1 for the battery failure analysis and conclusions.

Once the MSS equipment was placed on board the Glomar Challenger, Gould personnel continued testing the electronic recording systems while enroute to the

deployment site. After extensive testing several HCD-75 cartridge tape heads were found to be failing due to small wire breakages in the pick-up heads. On or about 30 August 1982 a coordinated effort between Gould, GMDI, NORDA, 3M, and the U.S. Navy resulted in an air drop to the Challenger of fifteen spare HCD-75 tape heads by a U.S. Navy aircraft. These spares were quickly used to repair and verify malfunctioning tape drives. Reference paragraph 6.1.2 for the tape drive failure analysis and conclusions.

After two attempts were made to drill a re-entry hole, efforts to deploy the BIP and BPP instruments was abandoned. On the first attempt the drill pipe broke in the hole, and in the second attempt the drill pipe could not be released from the casing. Due to casing shortages, time and weather the MSS '82 deployment operation was abandoned.

The Gould MSS equipment was returned to the U.S. via Military Airlift Command as part of the Glomar Challenger's demobilization in Yokohama, Japan.

5.2 Leg 91/1983 South Pacific Deployment and Recovery

5.2.1 MSS/83 Deployment

Glomar Challenger Leg 91 during the early Winter of 1983 provided a successful deployment of the DTU and BPP electronics. The South Pacific deployment location was site 595B in the oceanic crust near the Tonga Trench.

The Gould, BPP and DTU equipment were transported via Military Airlift Command (MAC) from Dover AFB, Delware to Norton AFB, California. The equipment was then transported to Christchurch, New Zealand and, subsequently, moved by truck to the MSS '83 mobilization site in Wellington, New Zealand.

BPP staging in Wellington went well. The silver-zinc batteries were filled with electrolyte and closely monitored using updated OEM procedures. (Cell #18 in battery sphere #1 was replaced on February 6th due to a slow discharge indication which could have turned into a hot short and destroyed the entire battery.) The Challenger sailed 16 January 83, as scheduled.

The Gould van and BPP sled were located in the ship's casing rack. This location proved to be in a hazardous area since the van's air conditioner was hit by a drill pipe

casing and required mechanical repairs before becoming operational again. A plastic tarp was placed over the van and BPP sled in order to provide a more protected environment for working on the BPP electronics.

Table 5-1 identifies the Gould activities with the DTU and BPP equipment prior to and during the MSS '83 deployment exercise.

Table 5-1

Gould Activities During MSS '83 Deployment Exercise

Jan	Activity	Comment
16	Tape Drive #13 failed to power up and initialize (status 0010/0051).	Replaced Tape Drive with spare unit.
17	Noted varying cell voltage readings when monitoring; experienced inconsistent results when performing tape formats/verifications.	Variations were found to be due to RFI from the ships CW transmitter; also noted that RFI was apparent on the tape drive read/write amplifier.
18	Tape Drive #8 failed to power up properly (status 00C4 - illegal command).	Replaced Tape Drive and retested satisfactorily.
18 (International dateline)	After re-assembling DARS, found that chassis was shorted to system ground.	Isolated ground to a shorted capacitor in Tape Drive #8 (motherboard); replaced capacitor.
	After re-assembling DARS again, DSC power relay would not switch off when power sequenced or reset.	Failure isolated to 'soft start' circuit; replaced two relay coil transistors and re-tested satisfactorily.
19	12 kHz pinger (altitude) and 9.5 kHz ATNAV transponder interferring with reception of 10.0 kHz SOH Communicator transmissions.	Installed adjustable Bandpass Filters at hydrophone input with limited success; 12 kHz pinger was removed from BPP and ATNAV transponder will be interrogated between SOH transmissions.
21	When performing EDME CAL on both BIPs found that SP-Z and SP-E channels were noisy on BIP #1, and only SP-Z was noisy on BIP #2.	Noise on SP-E channel was corrected by properly aligning telemetry in DARS; noise on SP-Z channel is due to interferring frequency on FSK at 45-55 kHz, unable to isolate source of interference. Problem only occurs on EM cable.

Table 5-1 (continued)

Gould Activities During MSS '83 Deployment Exercise

Jan	Activity	Comment
23	Experienced an intermittent problem where the spare DIA 130 volt regulator which would fail to power-up BIP #1 (fold-back).	Tested 130 volt regulator with full load - satisfactorily. Tested on BIP #1 - satisfactorily.
25	Experienced inconsistent results on 7 tape drives when performing format/verifications.	Unable to localize cause; suspect that RFI due to CW transmission is interference on tape drive read/write amplifier. Install known good tapes which were previously formatted and verified.
27	When EOTing tapes (positioning tapes at end-of-tape), tape drive #7 failed to power up.	Isolated failure to open conductor on 26 conductor ribbon cable; repaired and tested satisfactorily.
31	Cell voltage for cell #18, battery #1 observed to be decreasing at a rate of 0.5 mvolts/hour.	Continued to monitor cell #18 closely, activated a spare cell; charged battery and observed that cell # 18 continued to discharge; replaced cell #18 on 6 Feb 83 after additional monitoring.
Feb		
1	While monitoring BIP #1 during deployment, noted BIP voltage dropped; no command/control capability; re-try of power-up indicated excessive current.	Was finally able to power up BIP and establish communications (BIP at 220 feet); at 500 ft depth again lost power and communications; retrieved BIP, found water leakage to shield down to connector where it shorted to center conductor. Changed BIPs and reterminated EM cable.
5	BIP successfully deployed in borehole.	
6-7	Telemetry was adjusted in van prior to installation in sphere; once in sphere, and checked all short period channels that were noisy.	Determined that there was 250 sec phase shift in the telemetry when compared to being set in the van versus in the sphere due to cable impedance changes as a result of the hydroacoustic assembly (H/A) sensor power being drawn from the BIP power source; re-adjusted telemetry in sphere. All channels were checked out satisfactorily.

Table 5-1 (continued)

Gould Activities During MSS '83 Deployment Exercise

Feb	Activity	Comments
10	Lost BIP status/communications and MP-Z data channel after EM cable terminated to BPP.	Suspect failure to be in Bay #3 of the DTU in the BIP; performed calibrations under STC van control.
11	Identified that system ground was shorted to base of SOH transponder, +56 volts dc potential between case of SOH transponder and sled.	Located ground lug in SOH transponder electronics and isolated it from chassis ground; verified ground isolation and function of SOH transponder.
11	DARS system clock was incorrectly set to ZULU -6 hours. BPP sled was placed in water at 1400 hours.	Noted error for post processing.
11	Quality of SOH communication degraded rapidly after approximately 3000 feet, only able to receive SOH data intermittently down to approximately 14,000 ft. BPP sled reached bottom at 1145 hours.	SOH communications were degraded due to high ships noise - thruster and screw cavitation.
Test Configuration Comment 130 volt monitor did not work when system was connected to the test equipment rack due to shield of EM cable terminated to BIP case through a 10 KΩ resistor; monitor apparently functioned properly in deployment configuration.		

Once the BIP was deployed, real-time data was acquired and recorded during a 5-day shipboard recording period. Due to the need to test HCD-75 tape drives, only 84 hours of data was recorded by the Gould test van equipment. This included approximately 25 hours of the shot program and 59 hours of regional seismicity recordings. After the five-day shipboard recording period the BPP was prepared for deployment and the operational firmware initialized as described in paragraph 4.3, BPP Setup, Testing and Operation.

BPP status, communicated to the ship via the state-of-health transponder, was monitored on board the ship by the Gould test equipment rack (TER). The communication link was reliable down to a depth of approximately 3,000 ft, where the noise generated by

the ship's thrusters and screws began to interfere with transmissions. Down to a depth of approximately 5,000 ft, the status reported was normal. The system did report that the relative humidity in the electronics sphere had dropped to 25%. This was not considered critical. The system also reported that the crystal cooler power had been turned off, as planned; tape drive #1 was powered up and initialized; the recording format had changed, as planned; a full frequency calibration initialized and aborted, as expeced due to loss of BIP communications; that tape drive #1 had failed after approximately 4 hours of recording, the cause of which is not known; and finally, that tape drive #2 had been powered up, with a single frequency calibration initiated and aborted, as expected. The final system status was received from a depth of approximately 14,000 - 15,000 ft. The last system status reported was that the relative humidity was 25%. The SOH responder was then automatically turned off after 18 hours, as scheduled.

The Gould MSS support equipment was temporarily stored in a dock warehouse upon arrival in Papeete, Tahiti as part of the Glomar Challenger's demobilization. The R/V Melville would later retrieve the stored MSS equipment from storage in Tahiti in order to recover the BPP sled.

5.2.2 MSS/83 Recovery

After retrieving the MSS support equipment required to recover and evaluate the BPP, the R/V Melville proceeded to Site 595B. Upon arriving at the site, the IRR mooring system was released using the ATNAV command transponder. The IRR grapnel leg and riser leg were recovered in the process of retreiving the BPP sled.

Table 5-2 identifies Gould activities with the BPP sled recovery.

Table 5-2

Gould Activities During MSS '83 Recovery Exercise

Mar	Activity	Comments
23	The BPP sled was raised from the ocean floor and left suspended approximately 1,500 feet below the ship overnight.	The BPP was left at this point overnight due to personnel safety considerations.
24	The BPP surfaced at 1000 hours. It experienced many mechanical shocks with the ship's hull as it was brought aboard. Visual inspection was made of the BPP and its components.	(Paragraph 6.3 provides detailed observation, failure analysis and conclusions of the recovered BPP equipment.)
24	The EM cable was removed from the DARS and connected to the Gould TER and Geotech STC test equipment. Calibrations indicated the same BIP performance as measured at deployment time.	Five hours of seismic data was recorded at this time by the Gould Test Equipment Rack (TER) in parallel with the Geotech STC van.
25	Removed 20 cartridge tapes from DARS vessel - only three tapes were used during mission for a total seismic data recording time of 40.3 hours.	Assisted in repair of EM cable and deployment of dummy BPP.
26	The printing of state-of-health information from the tapes did not indicate a system failure. Selected FFT analysis indicated recorded data was valid and useable.	
27	Unable to copy MSS cartridges due to defective scratched tapes.	
28	Evaluated Battery Vessel #2 and discharged same using aviation lamps	Reference paragraph 6.3
29	BPP recorded state-of-health data was used to evaluate the crystal temperature and primary battery voltage histories.	The crystal temperature curve indicates a 0.2°C rise during the last 14 hours of the mission. Battery discharge characteristics were normal.
30	Evaluated Battery Vessel #1 and the BPP junction box.	Reference paragraph 6.2 for battery and junction box observations, failure analysis and conclusions.
31	The DARS DIA/DSC/DSA and hydro-acoustic assemblies were activated and evaluated to be fully functional.	

6.0 GOULD EQUIPMENT PERFORMANCE ANALYSIS

During the MSS 1982 deployment attempt the BPP experienced two major failures. The first occurred at dockside checkout and testing in Hakodate, Japan. One of two silver zinc batteries on the BPP melted down shortly after being filled with electrolyte. The second failure occurred while at sea aboard the Glomar Challenger during final system preparation. Eight of the 20 HCD-75 tape drive heads failed in the BPP's DARS electronics data storage assembly.

During the MSS 1983 Deployment and Recovery effort the BPP subsystem and the DTU component, located in the BIP subsystem, experienced major failures. The first occurred during the BIP installation when a loss of MP-Z seismic channel data and the command and status channel data in the DTU was detected. The second occurred during the time when the BPP was residing on the sea floor. A pressure cable failed and terminated data recording approximately two days after the equipment was deployed.

The following details each failure and outlines the analysis performed and conclusions reached.

6.1 1982 Deployment Attempt

6.1.1 Silver Zinc Battery Failure

6.1.1.1 Description

The two silver zinc batteries were activated on August 6, 1982 by Gould personnel using detailed procedures prepared and supplied to Gould by Yardney Electric Corporation.

These procedures are defined in Appendix B. At the conclusion of the filling process the voltage of both batteries were measured and recorded at 46.3 Vdc. The batteries were then allowed a 72 hour soak cycle, as stated in the operating instructions.

On Monday, August 9, 1982 Gould personnel discovered that one of the batteries had melted down. The following visual observations were made:

- The warehouse staging facility was completely filled with smoke;

- The battery located in pressure vessel #1 had burned to the point where it was reduced to ASH with congealed portions of silver residing on the battery mounting platform in the bottom of the pressure vessel. To illustrate the melt down, Figure 6-1 is a photo of a single battery cell which had melted down during equipment transport from Tahiti to Glen Burnie, Maryland;
- The battery and pressure vessel were still very hot;
- The outside paint of the pressure vessel had been discolored and blistered;
- Potassium hydroxide, the electrolyte used to fill the battery, had been expelled during the reaction and covered the entire BPP and surrounding equipment;
- All external pressure cables were visibly undamaged; however, the battery cable #1 was replaced with a spare cable because the connector potting integrity was in question and could have resulted in a high pressure leak;
- A detailed examination was made to determine if foreign metallic objects were placed near the battery or BPP wiring harnesses which may have caused a short circuit. None were detected.

Electrical testing ensured that the undamaged portion of the system was still operational. The remaining battery was disconnected with its voltage measured and recorded at 46.3 Vdc. The BPP's electronics were found to be completely operational.

The battery manufacturer was contacted and made aware of the situation. In the interim Gould personnel proceeded to clean up the remaining portion of the system and make it ready for deployment. A 24 hour watch was maintained on the remaining battery to protect against any further problems.

6.1.1.2 Conclusions

Gould personnel contacted the battery manufacturer and were informed of a possible condition called a "Hot-Short." It was presumed that during the battery shipping and handling an internal plate separator material punctured; therefore, the hot short

BURNED
CELL

Figure 6-1. Burned Silver-Zinc Battery Cell

occurred when the electrolyte was placed in the battery and the plates began to swell. The hot short occurred in one of the 25 cells in the battery pack. As the shorted cell heated up the condition got progressively worse until it melted adjoining cells, then a falling domino condition destroyed the remaining cells.

NOTE

The separator material in the batteries was intentionally made much thinner than normal silver zinc in order to increase cell density and thus available power per unit volume.

The battery manufacturer supplied Gould personnel a detailed addendum to the operating instructions for detection of hot shorts and the emergency safety procedures to follow in case of a cell casualty.

The damaged battery, pressure vessel, and associated cabling were replaced with spare equipment. The burned battery and respective pressure vessel was sent to the U.S. Military Disposal Office in Misawa City, Japan.

6.1.2 HCD-75 Tape Head Failures

6.1.2.1 Description

After the MSS equipment was loaded aboard the Glomar Challenger, Gould personnel continued testing the electronic recording systems. The equipment was located below deck on the vessel's tank top level. The equipment experienced some vibration due to the normal ships operations. The ambient environment in which the system was placed was dry and very warm, approximately 85 to 90° F. After extensive testing, six HCD-75 tape drive heads were discovered to have open circuits. Two days later two more tape heads failed with the same failure mode.

6.1.2.2 Analysis

A dissection of one failed tape head was attempted aboard ship to determine the cause of failure. This proved unsuccessful due to the lack of proper equipment aboard the

Challenger. On or about the 30th of August 1982 a coordinated effort between Gould, NORDA, 3M, and the U.S. Navy resulted in an air drop to the Challenger of 15 spared HCD-75 tape heads by a U.S. Naval aircraft.

These spares were quickly used to repair and verify malfunctioning tape drives.

6.1.2.3 Conclusions

Upon returning to the U.S. six of the failed tape heads were returned to 3M for failure analysis. Two of the six were examined and found to have broken wires inside the tape head. Later it was discovered that 3M had a manufacturing process problem. Epoxy used to seal the tape head was causing undue stress on the fine wires within the tape head. The problem had been corrected but affected heads manufactured with serial numbers between the range of 2000 through 2999. The failed MSS heads were within this serial number range. The heads were replaced by 3M under warranty at no charge. No further problems of this nature were discovered.

6.2 1983 Deployment and Recovery

6.2.1 Data Transceiver Unit (DTU) Failure

6.2.1.1 Description

During the BIP installation phase of the MSS Deployment Teledyne Geotech has complete electrical control of the BIP. Power to the BIP was cycled numerous times during installation. When Teledyne Geotech has control of the BIP the DTU is powered but does not report any status or seismic information to the STC van. Upon completion of the BIP installation, the EM cable was connected to the BPP to allow DTU testing.

6.2.1.2 Analysis

After extensive testing the DTU showed that the MP-Z seismic channel and the BIP status/command communications channel had failed. The BIP would not accept any calibration commands issued by the BPP and the MP-Z seismic channel had no activity when displayed on the strip chart recorder.

6.2.1.3 Conclusions

Upon examination of the DTU schematic diagrams it was concluded that the switching mode regulator (SMR) board in Bay #3 of the DTU had failed. The printed circuit boards located in Bay #3 are defined in Figure 3-2. The figure shows that all non-operating functions noted upon testing are powered only by the switching mode regulator in Bay #3. The phase lock loop and clock transmitter boards also located in Bay #3 are redundantly powered by the SMR in Bay #2 and Bay #3. These two boards were powered in this fashion to ensure that if the SMR in Bay #3 failed the DTU primary seismic data channels would still operate. Since the DTU continued to provide primary data to the BPP, a detailed examination of the SMR schematic diagram allowed Gould personnel to conclude that a fuse on the SMR board had blown, which protected the front end electronics of the SMR. This failure may have occurred during one of the power cycling operations of the BIP deployment. Further examination of the DTU failure cannot be performed due to the BIP currently residing in the borehole in the South Pacific.

During BPP recovery operations the DTU was tested in the same manner and found to be unchanged from installation testing.

6.2.2 BPP Post Recovery Analysis

Shipboard, San Diego de-mobilization, and Gould analysis activities are discussed with a conclusion paragraph summarizing the BPP post-recovery analysis.

6.2.2.1 Shipboard Activities

Upon recovering the BPP from the sea floor the following visual observations were made:

- The junction box pressure compensation bladder was approximately three times its normal size with the junction box contents consisting of liquid castor oil, castor oil in a foam state and an undetermined gas. The junction box bladder burst approximately one hour after the BPP surfaced; see Appendix A, photograph A-4.

- The outer "O"-Ring on battery vessel #1 was protruding through the top hemisphere/pressure ring interface. Approximately 18 inches of the "O"-Ring was visible;
- The pressure cable below battery vessel #2 was wrinkled and the outer jacket was split. This damage was located at the molded plug at the end of the cable just below the battery vessel. See Figure 6-2. Heavy corrosion was visible on the intermost legs of the cradle, also on the decking just below the sphere penetration of the battery vessel;
- The entire sled had aluminum oxide residue on the aluminum frame. Most of this was located on battery vessel #2's cradle;
- The paint on both battery vessels was chipped and blistered. Where paint had fallen off oxidation had taken place. The lower hemisphere of battery vessel #2 showed the most visible corrosion;
- Mud stains were evident as high as the pressure ring of battery vessel #2.

Immediately after GMDI personnel had completed recovery operations and secured the BPP to the deck of the ship, Gould personnel proceeded with the following tests and observations.

The vacuum ports on all three spheres were removed to ensure that there was no positive pressure inside the spheres. The results were as follows:

- Battery vessel #1 was found to be at ambient pressure,
- Battery vessel #2 was found to be slightly positive, and
- DARS vessel was found to be evacuated.

After rinsing the junction box and the EM cable connections, the DARS test cables were connected to the junction box. No system activity was evident. Efforts were made to turn on the electronics but the system would not energize.

The battery test monitor cables were connected to the battery spheres. Battery #2 was found to be completely spent and battery #1 was found to be fully charged.

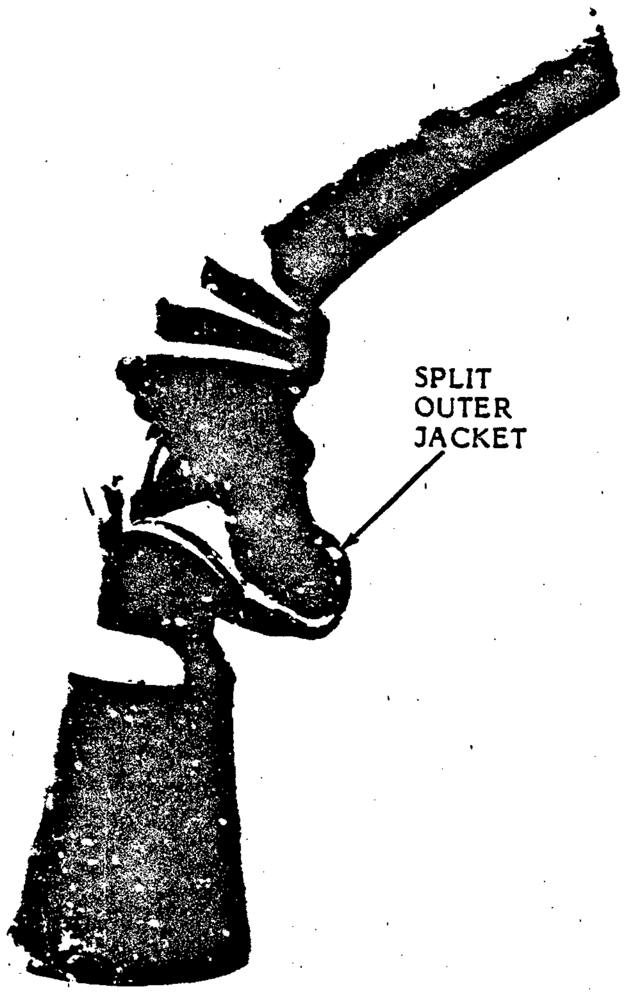


Figure 6-2. Pressure Cable Jacket Failure

Visual inspection of the junction box was performed. A burned wire on terminal block 1 position 5 was noted. This wire was the charge input circuit to battery vessel #1. The screw heads and crimp lugs were blackened and the nylon insulation on the crimp lugs were melted.

The EM cable was removed from the DARS vessel. The BIP was tested and found to be operating in the same manner as previously tested aboard the Glomar Challenger. Calibrations were performed, and the result indicated approximately the same response characteristics as the calibrations performed aboard the Glomar Challenger prior to the BPP deployment.

The DARS vessel was opened and all 20 tape cartridges were removed from the DARS electronics package. No visible damage of the electronics was noticed. First indications showed only three tape cartridges were used during the mission. Tape analysis began immediately to determine the system failure mode. State-of-Health headers were played back and hard copy print-outs were made.

It was found that tape cartridge number 1 recorded for 5 hours, 14 minutes, 40 seconds. Tape cartridge number 2 recorded for 38 hours, 10 minutes, 58 seconds. Tape cartridge number 3 recorded for 53 minutes, 47 seconds. The total system operating time was 44 hours, 18 minutes, 25 seconds. The total amount of seismic data recorded was 40 hours, 16 minutes, 25 seconds.

The first and last state-of-health information recorded on tape showed no indication of system failure.

FFT (Fast Fourier Transform) analysis on selected areas of the data cartridges was performed indicating that the 40 hours of recorded data were valid useable data.

The top hemisphere of battery vessel #2 was removed with the following observations made:

- The hemisphere appeared to be bonded to the pressure ring in some fashion. A rubber hammer was used to successfully free the hemisphere;
- The O-ring appeared to be undamaged;

- Corrosion was evident in the O-ring grooves and the entire pressure ring;
- A rubber hose was inserted under the battery deck and saltwater was discovered;
- The wiring harness was severed and completely disconnected from the connector at the bottom of the vessel;
- The battery package was tilted approximately 15° and was covered with a film of black soot;
- A strong odor of burning material was noted;
- All battery cell fluid levels were checked and found to be normal;
- Corrosion was evident at the base of the battery cage where it attaches to the battery deck;
- Water marks were noted within the battery vessel. This indicates water was sloshing around the bottom of the lower hemisphere;
- The pressure cable was removed from the bottom of the battery vessel. The insert in the connector at the vessel penetration was damaged. Some wiring from this insert was attached to the cable female pins.

The top hemisphere of battery vessel #1 was removed with the following observations made:

- The inner O-ring appeared to be undamaged. The outer O-ring was stretched but recovered to its normal size when the hemisphere was removed;
- A rubber hose was inserted under the battery deck and potassium hydroxide was discovered at the bottom of the battery vessel;
- The redundant battery diode located on the terminal block was found to be open due to a high heat situation. The diode mounting stud, soldered to the end of the diode, was disconnected. The 18 gauge wire was also melted through;

- The gauze inside the entrainment eliminators on the batteries appeared to have melted;
- There was no visible signs of cell fill fluid within the battery cells; and
- The cell jars that were visible were warped slightly.

Further inspection of the junction box was made. The following observations were noted:

- Condensation had formed on the inside of the Lexan Cover;
- When the cover was removed it was discovered that a corner of the Lexan Cover had been broken off. It was broken off approximately 1 inch inside the O-ring. Two of the outermost corners of the Lexan Cover were also broken off;
- The pressure cable connected to battery vessel #2 was removed from the junction box and saltwater was evident on the face of the connector. The connector had no evidence of corrosion; and
- The burned terminal in the junction box was removed and examined. The terminal block under the crimp lugs were also melted.

Connections were made between the charged battery and the junction box DARS power connections. The system was turned on and the following observation and tests were made:

- The state-of-health display indicated there was a leak in battery vessel #2. The cable to that vessel was removed from the junction box to verify the leak detector and the state-of-health display properly indicated a no leak condition;
- The leak detection circuits in both batteries were tested and found to be operational. This test was performed using a jumper in the junction box;
- The hydro-acoustic assembly was tested and found fully operational;
- The data buffer memory, located in the data storage assembly, was tested and found to be fully operational; and

- The tape drive system was tested, using the HCD-75 test firmware, and found to be operational. Tape drive #1 was used for this test.

Gould personnel continued other recovery operations including the following:

- The Gould test equipment rack recorded all calibrations performed by the Teledyne GEOTECH STC in addition to recording approximately five hours of real time seismic data;
- The EM cable termination became impaired beneath the ship and Gould personnel assisted Teledyne GEOTECH personnel in repairs; and
- The EM cable termination was attached to the dummy BPP and Gould personnel aided GMDI in re-deployment operations.

6.2.2.2 San Diego De-Mobilization Activities

In May 1983 Gould personnel traveled to San Diego, California to de-mobilize the MSS equipment from the R/V Melville upon its return from Tahiti. Due to the conditions during recovery at sea the battery pack could not be removed from the spheres. This task was performed in San Diego with the following observations:

- The battery in vessel #2 was removed and approximately 4 inches of mud and seawater were found in the bottom of the vessel;
- The battery in vessel #1 was removed and a small portion of potassium hydroxide was found in the bottom of the vessel;
- Both batteries were removed from the vessel's mounting hardware and transported to the San Diego Naval Salvage Depot. This task was handled by GMDI Logistics personnel;
- The BPP and associated equipment were prepared for shipment, by truck, to Gould's Glen Burnie, Maryland facility.

6.2.2.3 Gould DED Analysis Activities at Glen Burnie, Maryland Facility

The equipment arrived in late May at the Gould Glen Burnie facility. Gould personnel continued the BPP examination. The failed pressure cable was removed and the

cable connector termination was cut from the remaining cable. The rubber potted strain relief was cut off just prior to the stainless steel portion of the connector assembly. Refer to Figure 6-2. The remaining portion of the connector assembly was cut in half to reveal the inside of the connector. Refer to Figure 6-3. Further examination of the connector revealed that 4 to 6 inches of the electrical conductors of the cable was compressed into the housing of the connector. Refer to Figure 6-4.

The mud and seawater were removed from battery vessel #2. A large area of the vessel near the penetration had been corroded away. The area in question was approximately 4 inches by 8 inches long and approximately 1 inch deep (refer to Figure 6-5).

The vessel penetration assembly was removed and the connector pin insert removed from the housing. This revealed that a portion of the insert had been burned away. Refer to Figure 6-6.

Upon return of the equipment van the single battery cell that had showed internal short symptoms at sea was found to have melted down in the van. Minor damage to the van had occurred. The burned battery cell was packaged and taken to the Defense Property Disposal Office at Fort Meade, Maryland for salvage.

6.2.3 Conclusions

The BPP's failure to complete the 45 day mission was due primarily to the battery pressure cable failure. The following are conclusions and a description of the theoretical failure scenario which may have terminated the mission:

At some unknown water depth the battery pressure cable gave way to the exerted external water pressure causing the multi-conductor cable to be compressed into the connector housing. This resulted in a short circuit to the battery. Refer to Figure 6-4. When this occurred both batteries began to supply current to the short. By examination of the system wiring diagrams the battery in vessel #2 was located closer to the short and thus supplied more current than battery #1. During this condition the DARS electronics were supplied sufficient current to maintain proper operation. As the internal wiring of battery vessel #2 began overheating and deteriorating, the internal wiring at the cable

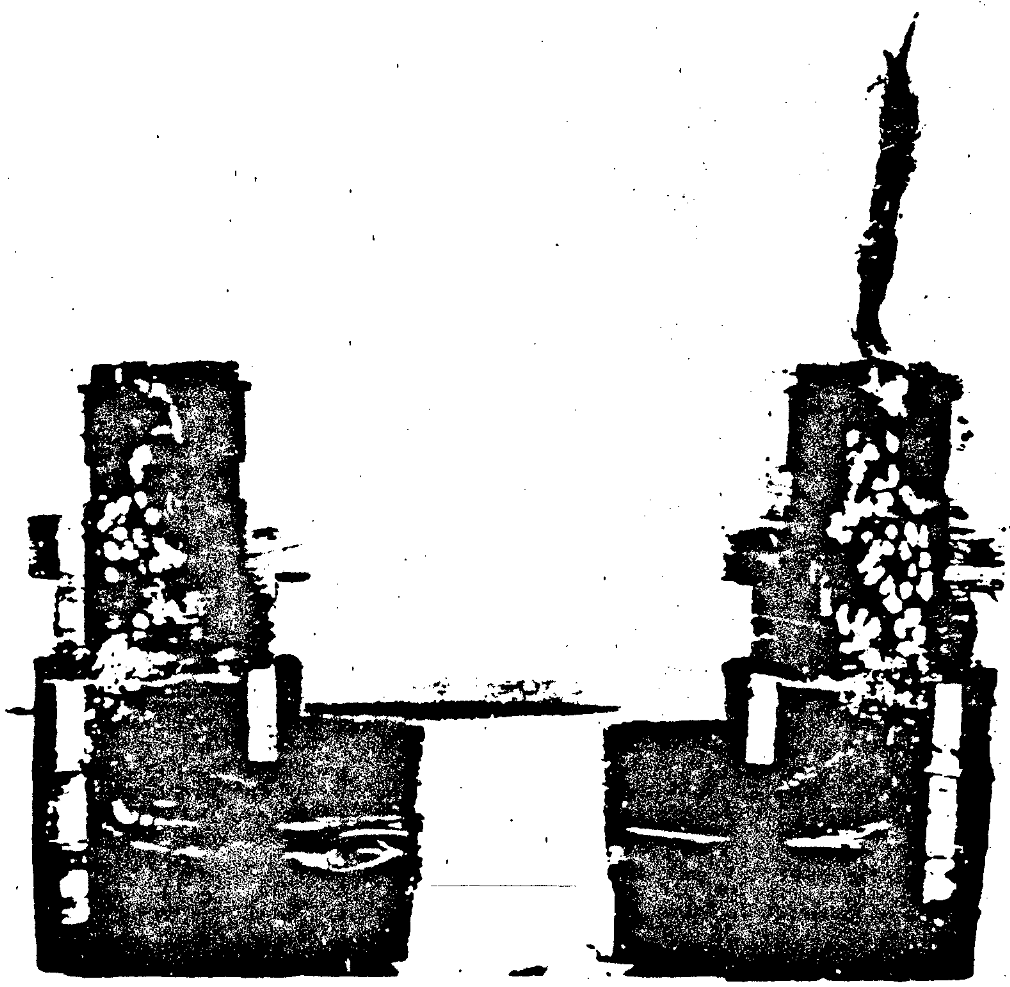


Figure 6-3. Pressure Connector Cross Section

Figure 6-4. Pressure Cable Cross Section Detail

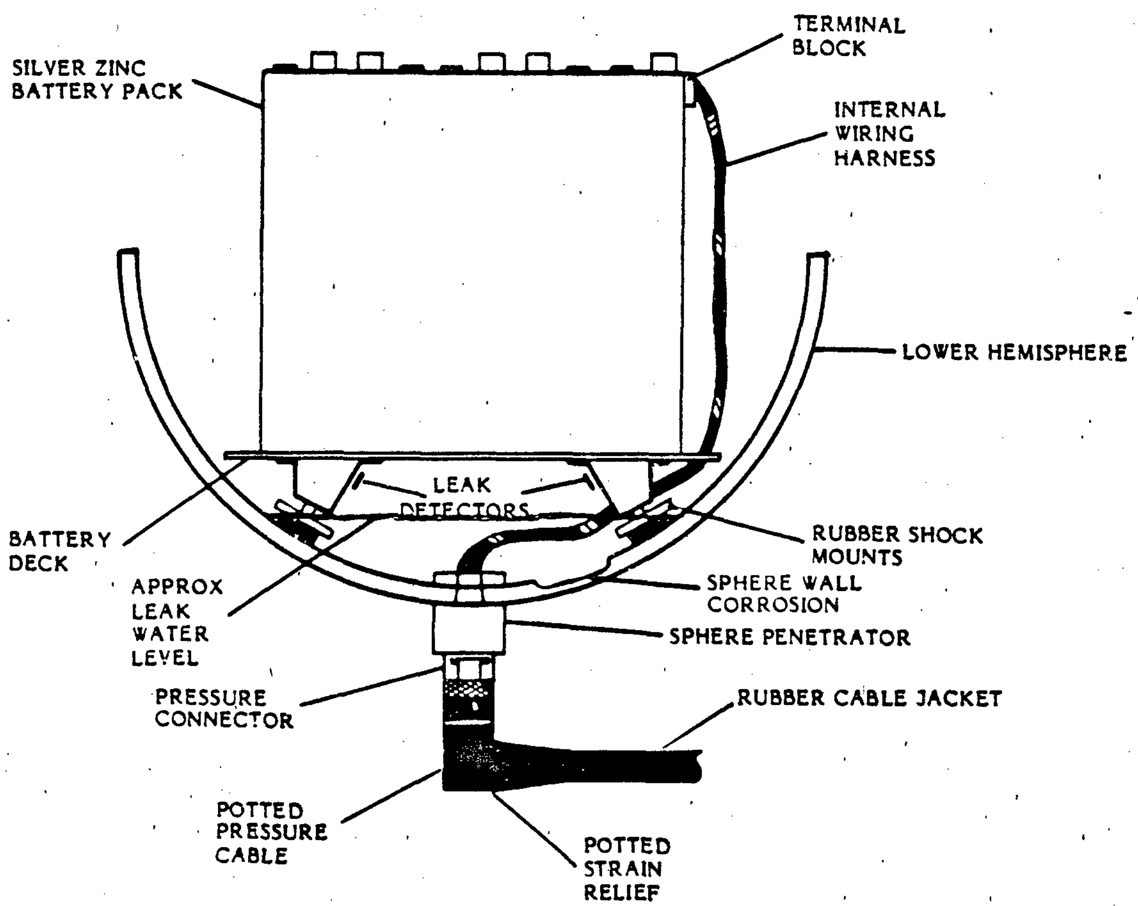


Figure 6-5. Battery Vessel Configuration

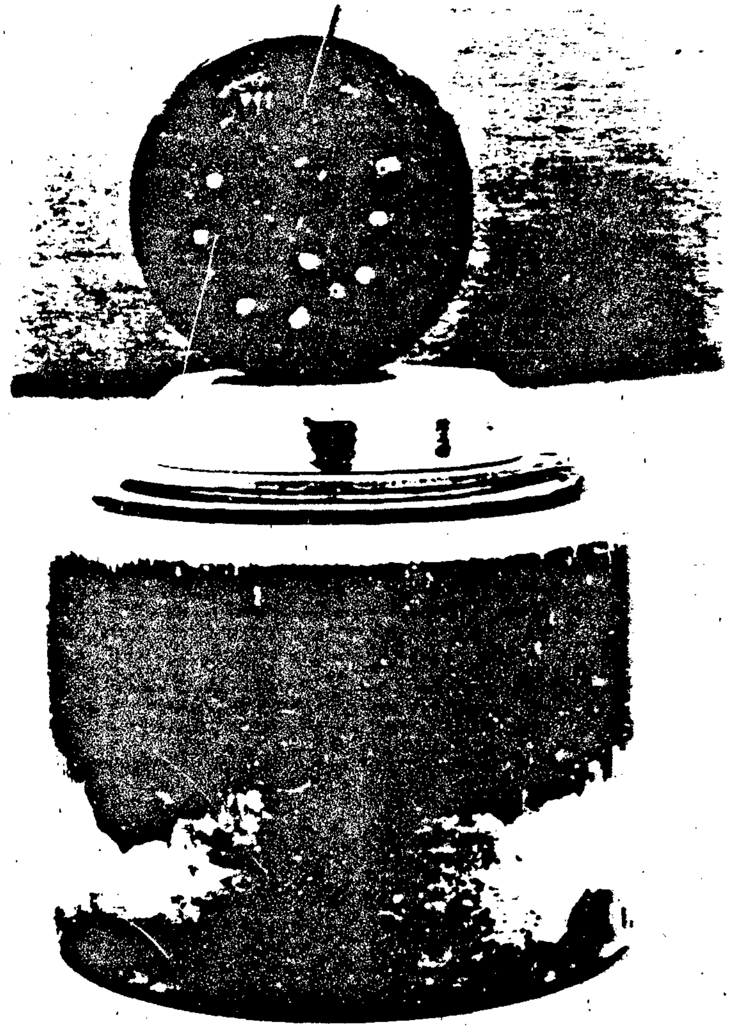


Figure 6-6. Pressure Connector Pin Insert

connector disconnected and shorted to the wall of the sphere. This resulted in the battery being completely discharged. This also contributed to the heavy oxidation found on the BPP and the large area of erosion found in the battery vessel itself due to the internal battery wiring coming in contact with the vessel wall. Refer to Figure 6-5 for the battery vessel configuration.

Meanwhile, the battery in vessel #1 continued to supply current to the short and also to the DARS electronics. As time passed the redundant diode located in battery vessel #1 began to overheat. Eventually the solder, that connected the diode to the terminal block, melted and the power source was quickly disconnected from the system. This explains why the SOH monitors showed no drop in voltage. The batteries capability to supply very high currents without any drop in output voltage also contributed to the SOH readings. As the battery in vessel #1 supplied high currents the electrolyte within the battery boiled, causing the internal vessel pressure to increase. As the BPP was raised to the surface the top hemisphere lifted slightly allowing the pressure to escape. This contributed to the "O"-Ring protruding from the vessel upon recovery.

During the short circuit condition the internal wiring of the junction box must have become very hot. This caused the castor oil to produce a gaseous reaction within the junction box. This reaction caused the internal pressure to increase and displace the castor oil into the junction box bladder. While the BPP was on the ocean floor the bladder remained compressed, as the BPP was raised the internal pressure caused the bladder to expand to the point where it burst shortly after recovery.

The pressure in vessel #2 must have increased, during that batteries discharge, to a point where it exerted enough pressure on the failed connector to stop the vessel from becoming completely flooded. Although each battery pressure vessel [illegible]pped with a leak detection sensor, no leak indications were recorded on tape or reported to the deployment ship via the BPP SOH communicator. This anomaly must be attributed to the leak detection sensors being mounted on the battery deck legs rather than at the bottom of the sphere where a small volume of fluids would collect. Refer to Figure 6-6.

Mr. John Sasse from NSRDC (Naval Ship Research and Development Center in Annapolis, Maryland) was asked to examine the BPP and, after discussing the system operation with him, he concurred with our findings.

6.3 Data Disposition

Seismic data was collected on HCD-75 cartridge tapes with Gould equipment during deployment, operational and recovery maneuvers. These included:

- Gould TER parallel recording of BIP SP/MP data channels during GEOTECH STC commanded BIP calibrations prior to shot program;
- Gould TER parallel recording of BIP SP/MP data channels during the five day short program prior to BPP deployment;
- DARS ocean bottom 40 hour operational recording of BIP SP/MP and hydroacoustic data channels (three cartridges);
- Gould TER parallel recording of BIP SP/MP data channels during GEOTECH STC commanded calibrations after BPP recovery; and
- Gould TER parallel recording with the GEOTECH STC of BIP SP/MP data channels for five hours prior to dummy BPP deployment.

At the direction of NORDA all MSS data cartridges were placed in the care of Ms. Emily McCoy, Center for Seismic Studies, Arlington, Virginia for conversion and analysis.

6.4 Suggested BPP/DTU Improvements

The following are suggested improvements to the existing system which would ease testing and system preparation for deployment:

DARS (mechanical)

- The crystal heatsink assembly should be mounted in such a way that it easily comes in contact with the sphere wall when the DARS electronics package is lowered into the bottom hemisphere;
- The internal penetration cable routing and support should be improved such that it does not become tangled in the rubber feet at the bottom of the DARS electronics package;

- Center tape drive deck support should be incorporated to prevent damage to the flat interconnect cables. Also, the tape drive deck interconnects should be made through rack and panel type connectors to make disassembly easier;
- The humidity control within the DARS vessel is crucial to the proper operation of the HCD-75 tape drive units. Incorporation of a dry nitrogen back fill procedure would better control the humidity in a low temperature, high ambient humidity location; and
- Mechanical shipping restraints should be incorporated within all pressure vessels to prevent damage to the equipment during shipment.

SLED (mechanical)

- Reduce one of the side dimensions of the sled so that special truck wide load permits are no longer necessary. The present sled measures 8 feet 4.5 inches in width. The maximum normal truck shipping width is 8 feet;
- Many of the forklifts, used to handle the sled during shipment, have very large forks. Enlargement of the forklift holes in the mud skirt of the sled would greatly improve handling of the sled. Also, the sled should be accessible from all sides. Presently it is only accessible from one side;
- Incorporation of tie down hardware on the sled would make transportation and attachment of the sled to the deck of a deployment ship easier; and
- No more than two pressure vessels should be utilized to greatly improve reliability to the system. One pressure vessel could contain all electronics, while the other could house the battery pack.

DARS (electrical)

- Improvement to the telemetry electronics should be designed to be less critical when changing from test configurations to the EM cable. The problem occurs in the c[illegible]er frequency sampling of data channels due to impedance changes incurred in different test set ups;

- Replace all HCD-75 tape drive hardware with the latest revision units. The tape drive units have under-gone many improvements since the procurement of the units currently in the system. This would greatly improve reliability of the data storage portion of the system; and
- All of the BIP and BPP SOH monitors should be re-calibrated to ensure accurate readings to be recorded on tape and displayed to the operators test console.

DARS (firmware)

- Incorporation of all Teledyne GEOTECH's sensor calibration commands to allow the DARS electronics to perform these functions independent of the STC van. Also, a command to initialize the DTU without power cycling the BIP would be very useful;
- The SOH table, displayed on the operators test console, should be updated more frequently, every five seconds, to aid in monitoring critical system parameters during testing and preparation for deployment; and
- Better definition of commands and responses, displayed on the operator test console, to make operating the system more user friendly.

DTU

- A commercial power supply should be incorporated in the DTU to eliminate any further problems that occurred during the BIP installation; and
- Incorporation of a digital phase locked loop (PLL) on the system recovery 81.92 kHz clock. This would improve system operating without critical adjustments and also increase DTU reliability.

Equipment Van

- Re-wiring of the AC distribution panel within the van such that the air conditioner, battery charger, and other support equipment could be powered directly from the ship's generators. The remaining electronic equipment

would still be powered from the AC line conditioner in the van. Presently the load on the line conditioner is at its maximum limit. Reduction of this load will add reliability to the line conditioner. During this re-wiring, external water tight outlets should be incorporated so that power needed outside the van could be easily accessible and the doors on the van can remain closed at all times;

- Additional work bench area and storage space should be incorporated to allow more useable work area within the van;
- A secure mounting platform should be fabricated to support the DARS electronics package while it resides in the van for test purposes;
- A small de-humidifier should be procured to aid the air conditioner when the van is located in a high ambient humidity area; and
- A CO^2 fire extinguisher should be procured for safety reasons.

Batteries

- Improvements to the silver zinc batteries should be made to guard against any further "hot short" melt downs.

APPENDIX A

GOULD MSS EQUIPMENT PHOTOGRAPHS

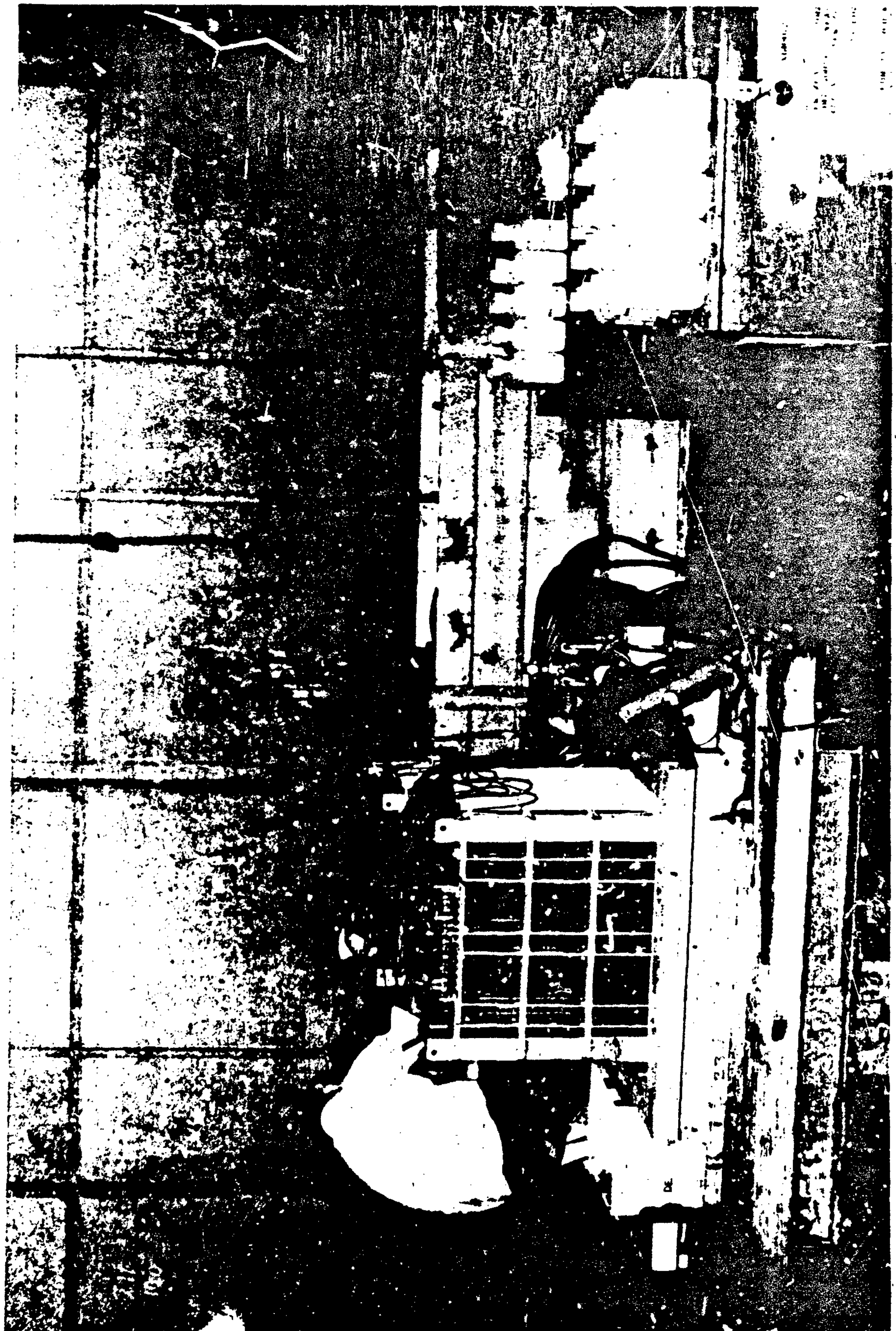


Figure A-1. Silver Zinc Battery Filling Process

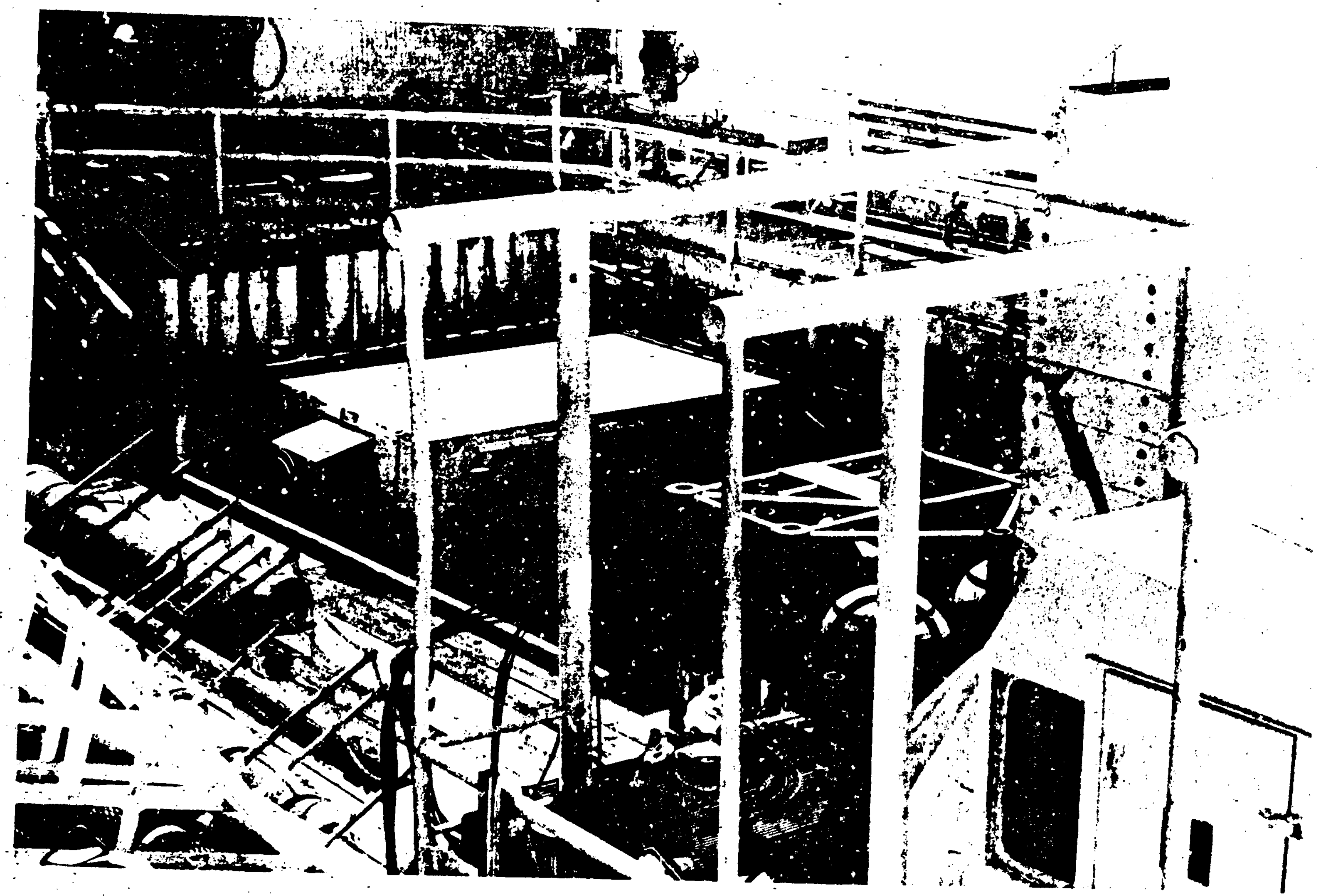


Figure A-2. BPP and Equipment Van in Glomar Challenger's Casing Rack

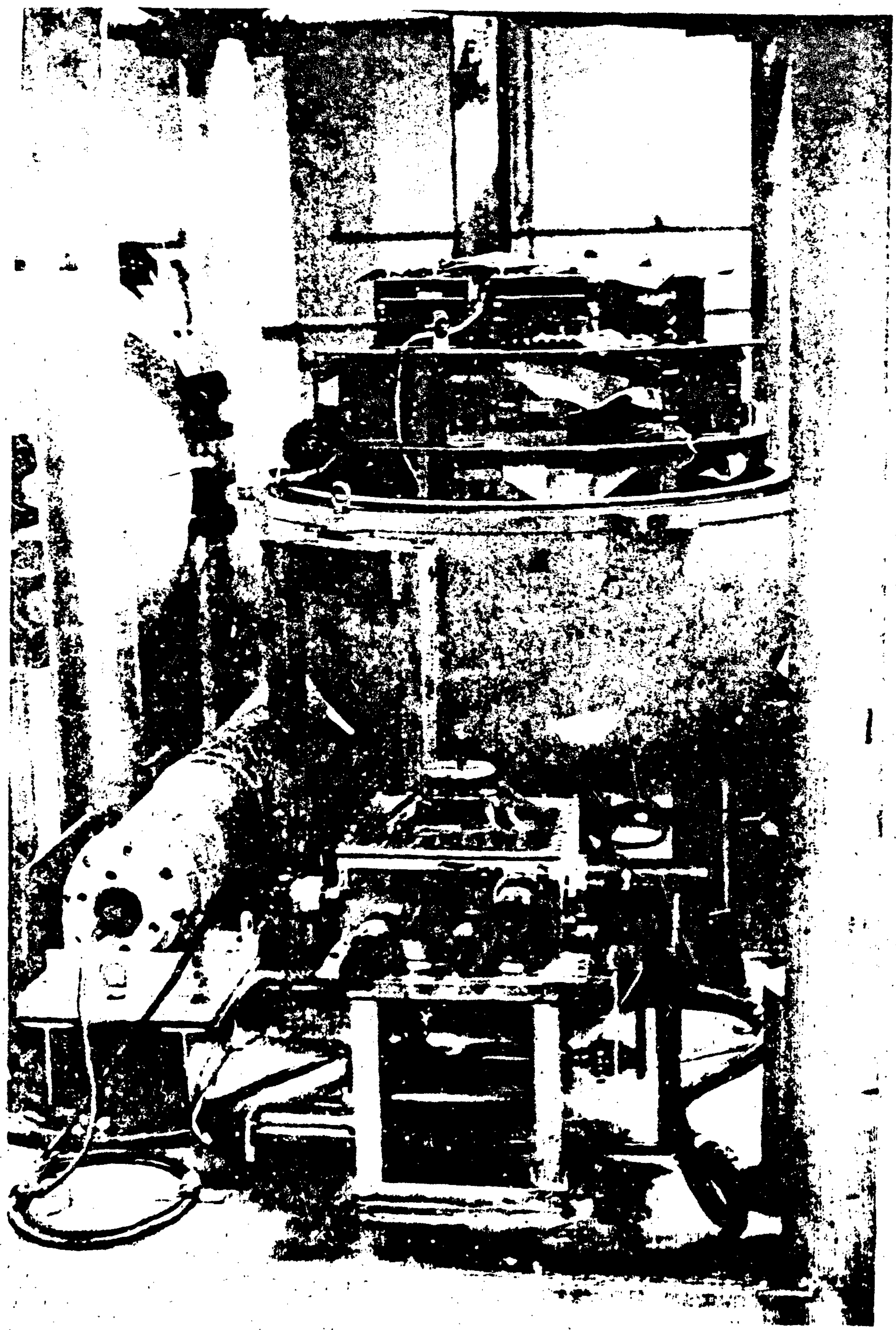


Figure A-3. DARS, Hydroacoustic, and Junction Box

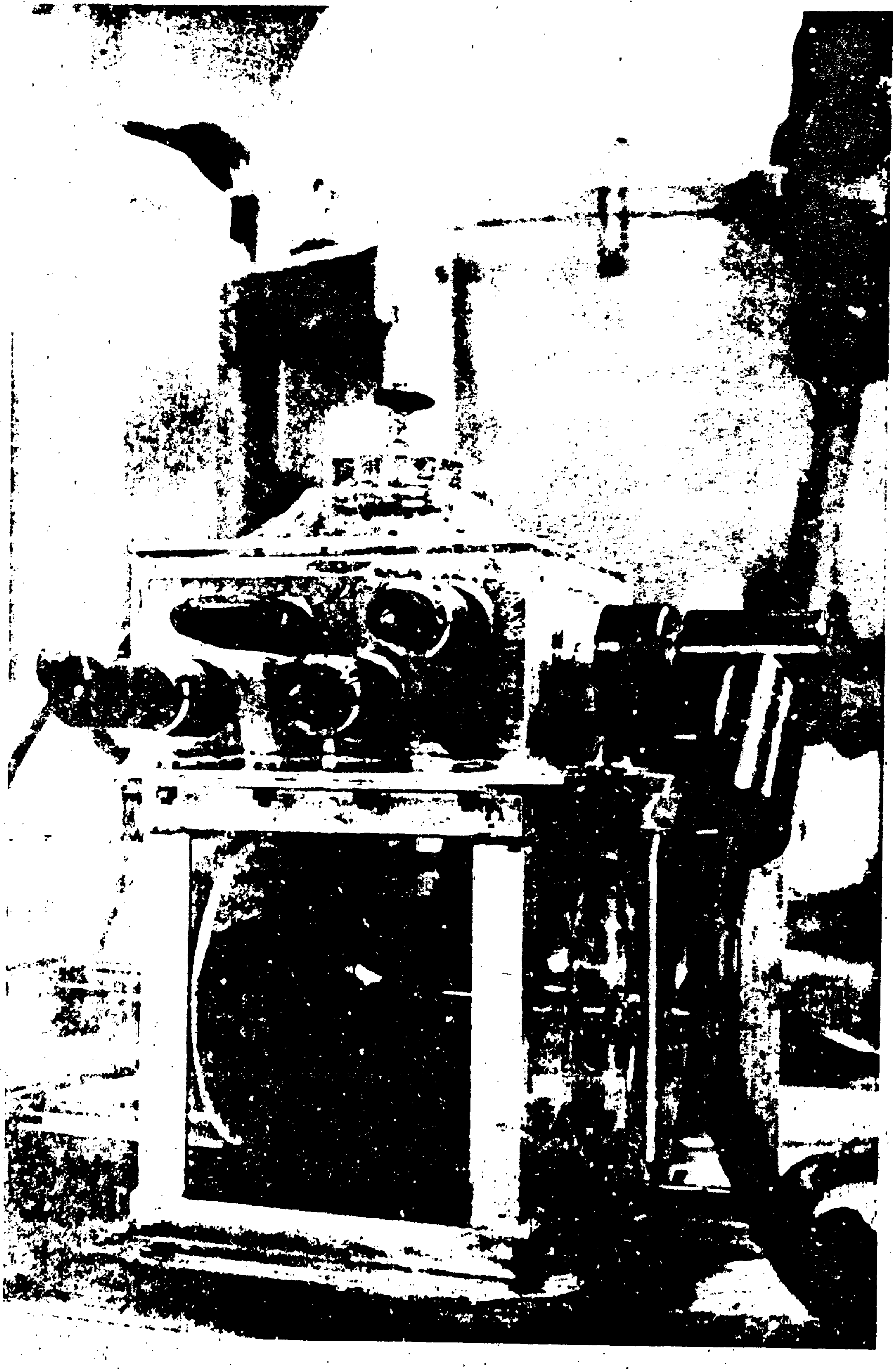


Figure A-4. Junction Box

Figure A-5. Silver Zinc Battery in Pressure Sphere

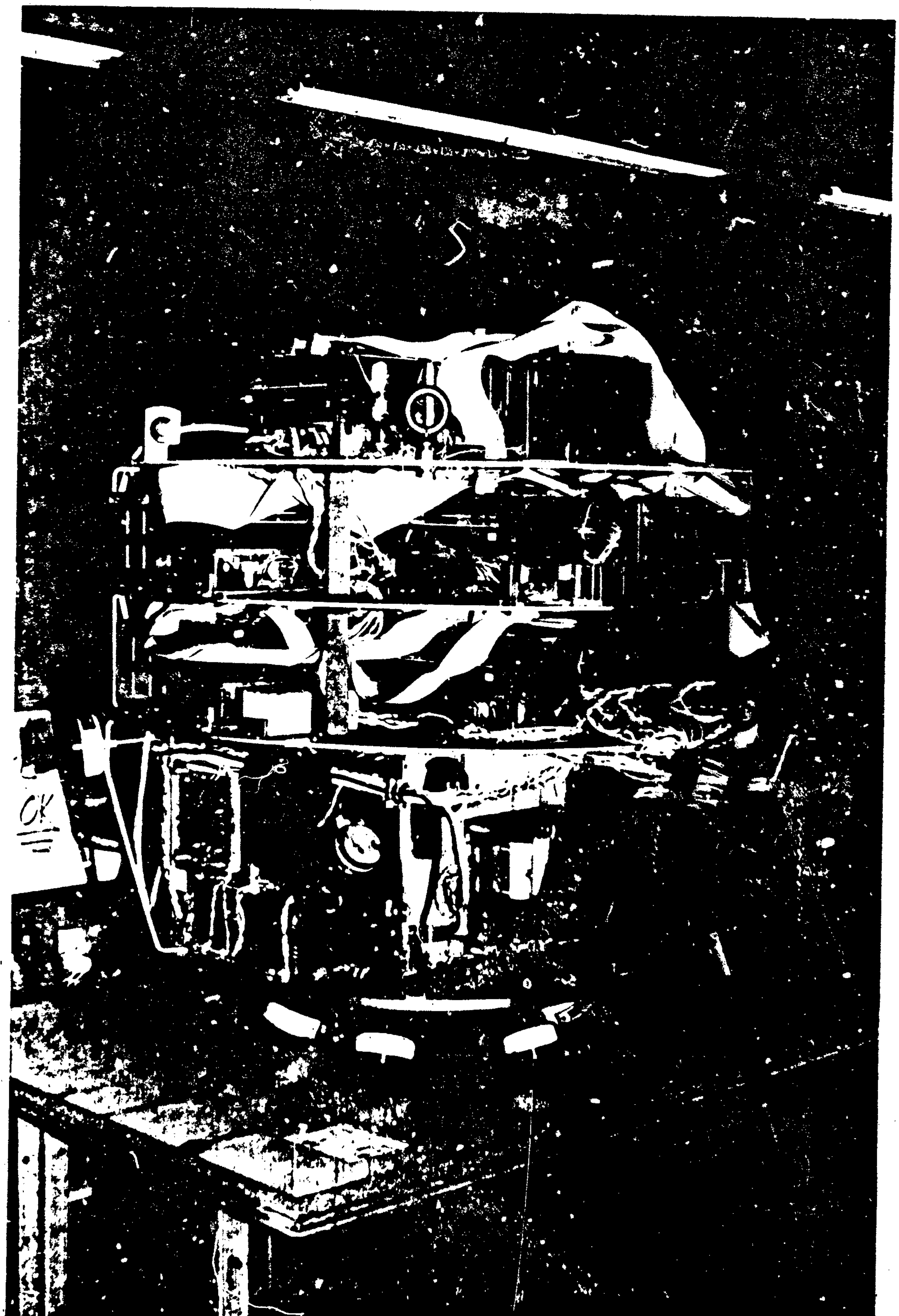


Figure A-6. DARS Electronics, View I

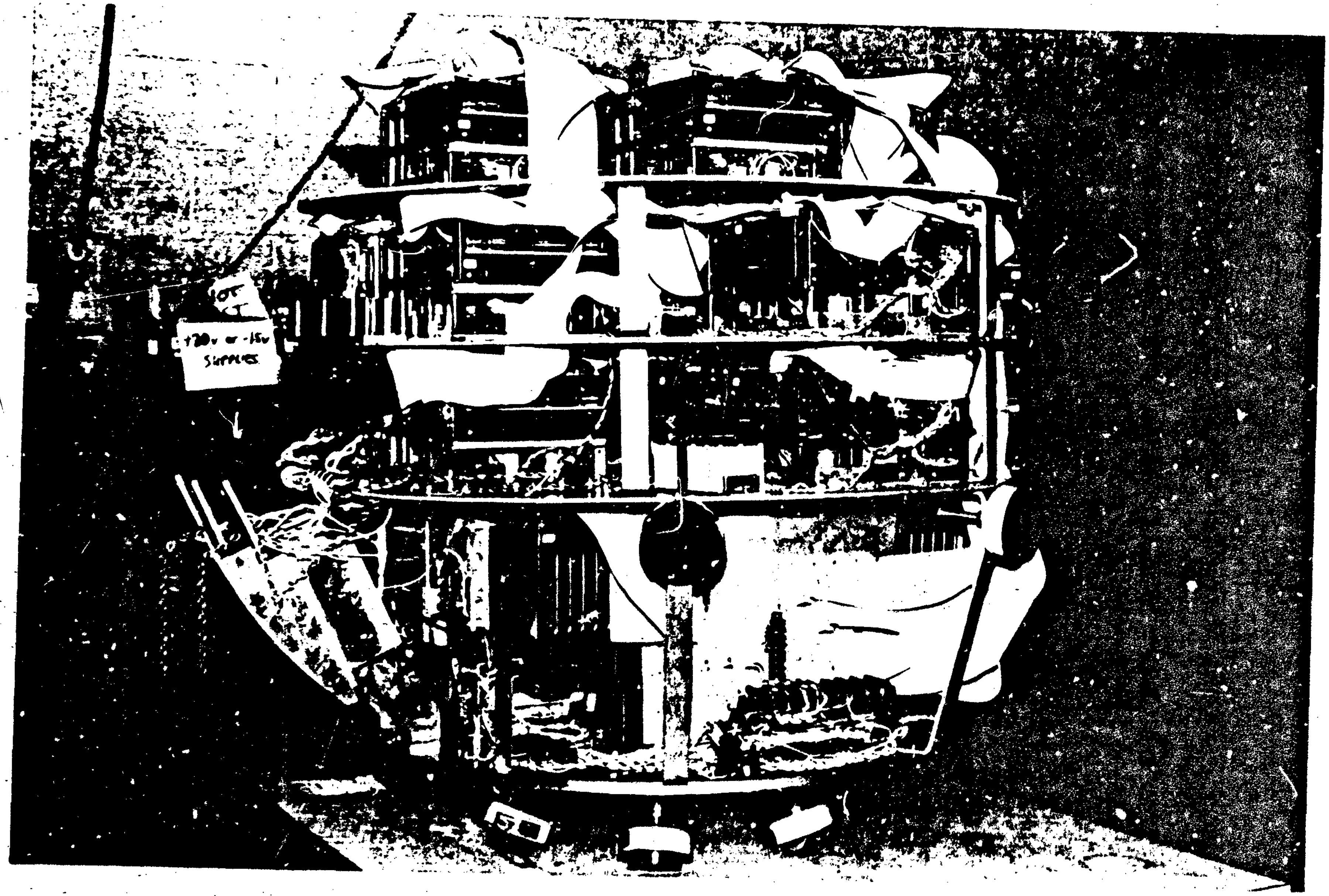


Figure A-7. DARS Electronics, View 2

APPENDIX B

OPERATING INSTRUCTIONS FOR YARDNEY SILVERCEL BATTERY

INSTRUCTIONS 421-22

REV A

APPROVED 6/1/82

OPERATING INSTRUCTIONS

ITEM: SILVERCEL BATTERY

MODEL: 25xPML2500

YARDNEY PART NO: 16950

NOMINAL CAPACITY: 2500 AMPERE-HOURS

A NOMINAL VOLTAGE UNDER LOAD: 38.75 VOLTS

BATTERY CONDITION (AS SUPPLIED): DRY UNFORMED

PREPARED K.C. Jennings

APPROVAL [signature] QA 18124

DATE 5-12-82

REV.A ECN 15501 [signature]

Yardney
ELECTRIC CORPORATION
YARDNEY ELECTRIC DIVISION

MECHANIC STREET
PAWCATUCK, CONNECTICUT 02891
599-1100

O.P. NO. 421-22
OPERATING INSTRUCTIONS FOR
YARDNEY SILVERCEL BATTERY
TYPE: 25xPML2500

MAY 1982

TABLE OF CONTENTS

PARA.	DESCRIPTION	PAGE
1.0	INTRODUCTION	1
2.0	DESCRIPTION OF THE BATTERIES	1
3.0	PRECAUTIONS	1
3.1	Precautions for Handling Electrolyte	1
3.1.1	General Comments	1
3.1.2	Antidotes, Internal	1
3.1.3	Antidotes, External	2
3.1.3.1	For the Skin	2
3.1.3.2	For the Eyes	2
3.2	Precautions for Handling the Battery	2
4.0	BATTERY ACTIVATION	2
5.0	CHARGING PROCEDURE	4
5.1	General	4
5.2	Booster Charging	5
5.3	Modified Constant Potential Charging Method	5
5.4	Constant Current Charging Method	5
6.0	MAINTENANCE PROCEDURES	5
APPENDIX I	Vacuum Filling Schematic	

O.P. NO. 421-22 MAY 1982
OPERATING INSTRUCTION FOR
YARDNEY SILVERCEL BATTERY
TYPE: 25xPML2500

1.0 INTRODUCTION

1.1 The Yardney Silvercel Battery is a silver-zinc alkaline battery which differs considerably from the more familiar lead-acid battery and to a certain extent from other alkaline batteries such as nickel-cadmium, nickel-iron, etc.

Silver and zinc are employed as the electrodes. The electrolyte is a strong solution of potassium hydroxide (KOH). The techniques for operating the Yardney Silvercel Battery are quite simple and should be followed closely for optimum performance.

The overall chemical reaction for this battery is as follows:

$$Ag + Zn(OH)_2 \rightleftharpoons AgO + Zn + H_2O$$

Discharged Charged

1.2 These cells are manufactured in the dry charged condition, i.e., after the addition of the proper amount of electrolyte and elapsing of the proper soaking time, the battery is ready for use.

2.0 DESCRIPTION OF THE BATTERIES

2.1 The battery is an assembly of 25 series connected PML 2500 cells, contained in an aluminum frame. The approximate overall dimensions of the battery are: 25.062 in. x 26.062 in. square x 21.5 in. high. The approximate weight of the battery is Dry - 813 lbs., Wet - 953 lbs.

3.0 PRECAUTIONS

3.1 Precautions for Handling Electrolyte

3.1.1 General Comments

The electrolyte (a strong solution of potassium hydroxide) is alkaline and corrosive. It should be handled with care. If neglected the electrolyte will cause serious burns when it is permitted to come in contact with the eyes or skin. Alkali-proof apron, rubber gloves, and splashproof goggles or a face mask are recommended for personnel engaged in the handling of the electrolyte.

3.1.2 Antidotes, Internal

3.1.2.1 Give large quantities of water and a weak acid solution such as vinegar, lemon juice, or orange juice. Follow with one of the following: white-of-egg, olive oil, starch water, mineral oil, or melted butter. Obtain medical attention at once.

3.1.3 Antidotes, External

3.1.3.1 For the Skin: Wash the affected area with large quantities of water. Neutralize with vinegar, lemon juice, or 5% acetic acid and wash with water. If irritation persists, or if extensive areas are affected, obtain medical attention.

3.1.3.2 For the Eyes: Wash with saturated solution of boric acid, or flood with water. Use this first-aid treatment until medical aid can be summoned.

3.2 Precautions for Handling the Battery

3.2.1 The battery is capable of supplying unusually high currents if it is accidentally shorted. A prolonged short may cause serious burns to personnel and may destroy the battery. To avoid accidental short circuits, all tools used in connection with the battery or cells must be properly insulated with a double layer of electrical tape or varnish.

4.0 BATTERY ACTIVATION

NOTES: 1. Batteries not to be used within 30 days of receipt should be stored in the dry condition.

2. For batteries shipped in the formed, wet and charged, or formed, wet and discharged condition, skip to paragraph 5.

4.1 Each battery is furnished with a filling kit containing the following items:

ITEM	QUANTITY	DESCRIPTION
1	60	32 oz. Polyethylene Bottles containing 815 cc of Electrolyte 'A' (45% KOH) (2 bottles per cell)
2	1	Funnel
3	1	Entrainment Eliminator Assy., P/N 15979
4	1 Set	Operating Instructions (O.P. No. 421-22)

A

4.2 To properly fill each cell of the battery with electrolyte, proceed as follows:

(a) Unscrew the entrainment eliminator assembly from each cell. Retain, as it will be replaced after filling.

(b) Place the funnel provided in the filling kit into the cell vent hole.

(c) Remove the cap from an electrolyte bottle containing 815 cc of electrolyte.

(d) Pour about half the contents of the electrolyte bottle into the funnel. When this electrolyte has been transferred into the cell by gravity, pour the other half very slowly into the funnel. Do not remove the funnel until all the electrolyte has entered the cell.

(e) Repeat steps (c) and (d) until two (2) bottles of electrolyte have been transferred into the cell. Save the funnel for use in other cells.

CAUTION

(1) Pouring the last part of the electrolyte too quickly may result in overflow of electrolyte through the vent hole.

(2) To avoid errors, fill one cell at a time.

(f) Using rags, remove any electrolyte spillage and debris from cell tops and replace the entrainment eliminator.

4.3 Preferred Filling Procedure (Vacuum Filling)

4.3.1 Equipment Required

a. Vacuum Pump and Associated Hardware

b. Vacuum Cylinder

c. Rubber Gloves

d. Face Mask or Goggles

4.3.2 Procedure

(a) Remove entrainment eliminator cap and bubble breaker material (white netting) from entrainment eliminator assembly. Retain for future use.

(b) Set up vacuum pump and trap assembly (Appendix 1).

(c) With entrainment eliminator in place, lightly push rubber stopper into eliminator hole.

(d) Remove cap from one (1) electrolyte bottle and lightly push rubber stopper into bottle opening. Ensure pick-up tube is within .125 inch maximum of bottom of bottle and valve No. 2 is closed.

(e) Open valve No. 1, start vacuum pump and slowly increase to 20-25 inches on vacuum gauge and hold for five (5) minutes.

(f) Close valve No. 1 and open valve No. 2 to allow KOH to enter the cell. Close valve No. 2 and repeat steps (e) and (f) again.

(g) Remove the empty bottle from the assembly. Repeat steps (d), (e) and (f) for a second bottle. IMPORTANT: Each cell requires two (2) bottles of electrolyte.

(h) Install bubble breaker material and replace entrainment eliminator cap.

(i) Using rags, remove any electrolyte spillage and debris from cell tops.

(j) Continue the vacuum filling process for all remaining cells.

4.4 Soak - Allow battery to soak a minimum of 72 hrs., then booster charge.

5.0 CHARGING PROCEDURE

5.1 General

5.1.1 For best results, all charging should be done at an ambient temperature of 65°F to 90°F.

5.1.2 Charging can be accomplished by either the modified constant potential or the constant current method. While the constant current method provides the fastest means of achieving a normal input, the modified constant potential method requires less personal attention and less complex equipment.

WARNING

The battery voltage, while charging, should not be allowed to exceed 50.5 volts during any charge. Adequate input is normally obtained at this point. If charging is not stopped, it will cause excessive gassing, detrimentally affecting the cells.

5.2 Booster Charging

In the event an activated charged battery is subjected to an extended wet stand period (in excess of 30 days), it is normal to experience a slight drop in capacity for the succeeding discharge cycle. If after activation (in the dry charge state) or at the end of the wet stand condition (in the charged condition), it is desired to raise capacity to a maximum level before discharge. Then the battery may be booster charged as per either method below.

5.3 Modified Constant Potential Charging Method

This type of charge system consists of a constant voltage supply modified by a current limiting circuit or resistor. A potential of 55.0 volts is recommended. For optimum performance, when charging by this method, the inrush current should not exceed 30 amperes. No current adjustments are required during the rest of the charge.

5.4 Constant Current Charging Method

A Charge the battery at a constant current of 20.0 amperes, until the battery voltage, while charging, reaches 50.0 ± 0.2 volts. It should be noted that the current will have to be adjusted throughout the charge.

6.0 MAINTENANCE PROCEDURES

6.1 A minimum of maintenance is usually required to keep the Silvercel battery in optimum operating condition. Cell tops and terminals should be kept clean and dry.

6.2 To assure maximum intercell conductivity, it is also recommended to check occasionally the tightness of the caps of intercell connectors. Each cap should be tightened to a torque of 30-40 inch-pounds.

CAUTION

Do not loosen or tighten the preset nut at the base of each cell terminal.

O.P. NO. 421-22
OPERATING INSTRUCTIONS FOR
YARDNEY SILVERCEL BATTERY
TYPE: 25xPML2500

MAY 1982

APPENDIX I

VACUUM FILLING SCHEMATIC

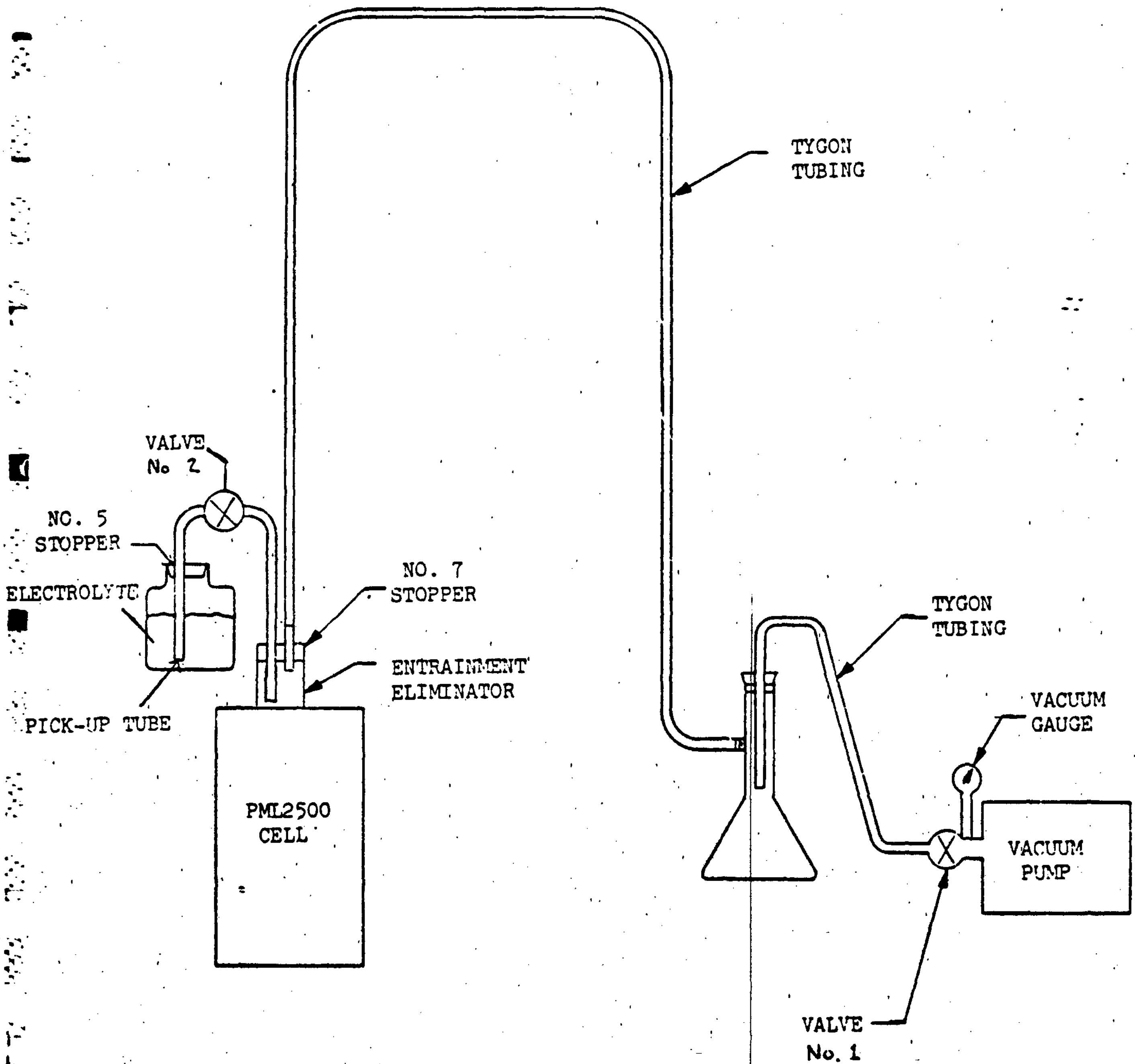


FIGURE 1 - VACUUM FILLING SCHEMATIC

Addendum To O.P. 421-22

A-1 Detection of Internal Shorts

a. General - Shorts will usually be detected from cell voltage readings. Therefore, the key to early detection of developing shorts is the periodic checking of cell voltages. For this purpose, the exact voltage of a particular cell is often less important than its voltage relative to all the other cells in the battery.

Cell voltages are monitored via the pigtails on the intercell connectors. When the battery is on open circuit, the resistance between a cell terminal and the point of measurement at the pigtail will not affect the reading. During charge and discharge, voltage drop in the terminal, connector and contacts could affect the voltage reading. However, with the low rates of charge and discharge in this application, connector resistance will not be a significant factor.

Scan the voltage of every cell in the battery at least once during every 24 hours. This includes the time when the battery is on open circuit. Scanning during charge and discharge must be more frequent. If a cell's voltage begins to drop when the remainder of the cells are maintaining a voltage level or are rising, a short may be present. Personnel are thereby alerted to monitor that particular cell and confirm or disprove whether there is, in fact, a short.

b. Charged Stand - A cell would be suspect if the voltage dropped below 1.850 volts. The rate of drop depends on the magnitude of the short and the state of charge of the cell. If the cell is partially discharged rather than fully charged, three days might be required for the voltage to go from 1.85 to 1.84 volts. A sizeable short would usually show up within 48 hours on stand. Immediately after any full charge, a cell OCV must read at least 1.850V. Anything less than 1.850 is a sign of a short and action must be immediately taken per A-3.

c. Charge - During most of a charge, cell voltage is near one or two voltage plateaus. These plateaus or levels vary with charge rate and the age of the cell, but are in the 1.6+ and the 1.9+ volt range. There is a transition period between voltage levels in which the voltage may peak and fall back normally.

Furthermore, if the battery is only partially discharged, the first (1.6V) level may be short or non-existent. Allow 15 to 30 minutes after the last cell makes the break upward from the first to the second level before trying to evaluate cell condition.

If a cell continues to decline through several successive readings. the cell is probably shorted. Stop the charge, verify per A-2b and take action per A-3.

d. Discharge - The fact that a cell limits the discharge does not automatically mean that cell has a short, since it could be out of balance for other reasons. If, after all cells are on the long, relatively flat portion of the discharge curve, one cell is 0.06 volt or more lower than the next lowest cell, a short might be suspected.

A-2 Verification

a. Charged Stand - Once a suspicious condition is indicated, check the immediate past history of the battery to see if it might be less than fully charged. Check the voltage at the cell's terminals to see if it differs from that read at the pigtails. If both checks are negative, the cell is shorting.

b. Charge - Once a cell is suspected of having a short, continue to monitor and record the cell's voltage. If the downward trend continues for 30 minutes, the cell is shorting.

c. Discharge - If a cell has developed a short during discharge, the voltage may recover somewhat once the load is removed. Let the battery stand for an hour. If, during that period, the voltage of the suspected cell starts or continues down, the short is confirmed and the battery should not be recharged. Action must be taken per A-3. If, at the end of the hour, the voltage has not started down, recharge with frequent monitoring using the indications in A-1C as a guide.

A-3 Action

a. Slow Short - A cell with a short should be replaced as soon as feasible. With a slow short:

1. Isolate the battery.
2. Discharge the cell to 0 volts. Remove quick disconnect bus to permit attaching a load such as a resistor to the terminals. The discharge rate should not exceed the 100A rate.
3. Replace shorted cell with a spare cell.

b. Hot Short - If the short is of such a magnitude that the voltage is dropping rapidly:

1. Isolate the battery.

CAUTION: There is a small amount of mercury in the negative electrodes. This may vaporize during a hot short and some may be carried out in gas or boiling electrolyte. Avoid contact with or breathing vapors in the immediate area of a casualty. In the event of a short resulting in smoke or fire, isolate the area and notify the officer-in-charge or medical officer.

2. Recognize that large quantities of gas are probably being evolved and that they are likely to be flammable.
3. Permit cell to discharge itself.
4. Replace cell with spare.

c. Cell Replacement - Replacement of a cell, including removing the shorted one and installing a new one, is described below. Review the precautions in Section 3 of the main body of the O.P.

c. Cell Replacement (Con't)

1. Remove shorted cell.

   a) Have a replacement cell at hand, braced in the direction perpendicular to the plane of the electrodes. Do not remove bracing until the defective cell is out of the battery.

   b) Remove the intercell connectors from the cell to be replaced and from the adjacent two cells. Unscrew the caps and lift the connectors free.

   c) Reinstall one end of each connector for use as a handle for lifting.

   d) Reduce the pressure in the battery by removing one or more of the side shims if possible.

   e) Lift the cell from the pack by exerting a steady upward force.

   f) Place shorted cell in a secure area. If there is evidence of smoke or vigorous gassing, remove entrainment eliminator and immerse cell in water.

2. Install new cell.

   a) Remove cell bracing.

   b) Use thin metal or plastic shims as guides to start the cell into the pack.

   c) Lubricate cell case with mineral oil or talc.

   d) Check to be sure terminals are oriented properly, relative to the rest of the battery.

   e) Push cell into place.

   f) Do not attempt to replace side shim(s).

   g) Install new intercell connectors, if available. If not, use original connectors. Dip pins of intercell connectors in mineral oil prior to insertion into cell terminals.

GOULD

APPENDIX C

SHIPBOARD PORTABLE INSTRUMENTATION VAN SPECIFICATIONS

29 Oct. 1982

MSS83

SHIPBOARD PORTABLE INSTRUMENTATION VAN

MINIMUM SPECIFICATIONS

REQUISITION NUMBER ______________

1. OVERALL DIMENSIONS:

   8 feet wide by 12 feet long by 8 feet, maximum external height. Inside ceiling height shall be a minimum of 6 feet, 6 inches to the florescent fixtures.

2. ROOF: The roof shall be 2-1/8 inches thick laminated panel roof. The exterior member shall be 1/4 inches A/C exterior grade fir plywood. The interior finish shall be aluminum with a baked white enamel finish which is bonded to 1/4 inch A/C exterior grade fir plywood. The exterior and interior members to be glued and pressure bonded to 1-1/2 inch of high density flame retardant expanded polystyrene foam insulation. Prior to fiberglassing all cracks and voids, shall be filled with hondo and sanded smooth. The exterior shall be completely fiber glassed, white -- with a mixture of polyester resin and chipped fiberglass sprayed uniformly over the complete roof surface.

3. EXTERIOR WALLS:

   The walls are to be laminated consisting of plywood exterior, 1-1/2 inch high density flame retardant insulation and an interior of 3/8 inch plywood over layer with prefinished light birch 1/4 inch paneling. The entire exterior including roof is to be coated with 1/8 inch chopped roving fiberglass with gel coat finish.

4. DOORS: See enclosures 1, 3, 5. Large equipment access door opening is to be 72 inches wide by 6 feet, 8 inches high with no sill as per Enclosure 3. Personnel door is to be 36 inches wide by 6 feet, 8 inches high as per Enclosure 5. Swing directions and location of both doors are shown on Enclosure 1. All door openings to be water splash tight mounted with stainless piano hinges on galvanized steel frames. Aluminum drip hoods shall be installed over each door opening. Latching hardware shall be Kason 877 padlocking pull handles.

5. FLOOR: See Enclosure 1. The floor shall be 2-5/8 inches thick panel floor consisting of 1/4 inch A/C exterior grade plywood on the exterior bonded to 1-1/2 inches of high density, flame retardant polystyrene foam insulation. The interior plywood is 3/4 inch A/C exterior grade fir plywood which is in turn glued and pressure bonded to the foam insulation. The panel is attached to the floor joists with self tapping screws. The bottom shall be undercoated with a heat resistant petroleum asphalt base material. The floor shall be fiberglass coated. On area shown as Area A, flooring will consist of 1/4 inch thick diamond studded steel to be welded directly to channels.

6. SKID: Two full length runners of 10 wf 22 steel beams with three WF beam crossmembers. Skid ends shall be 4 inch schedule 80 steel pipe. Floor joist under diamond studded steel plating shall be C5 x 6.7 channel on 12 inch centers. Floor joist under panel floor shall be 2-1/2 inches by 2-1/2 inches by 1/4 inch steel angle on 24 inch centers. All welded construction. Skid shall be dimetcoted.

7. WORKBENCH:

Work bench is to be constructed as shown in Enclosure 7. To be constructed of 1 inch plywood with formica laminated top.

8. SLING:

A lifting sling capable of supporting van for shipboard loading, unloading operations is to be provided. Also, a spreader assembly shall be provided so that the cable sling does not come in contact with the upper edge of the exterior walls.

9. AIR CONDITIONER:

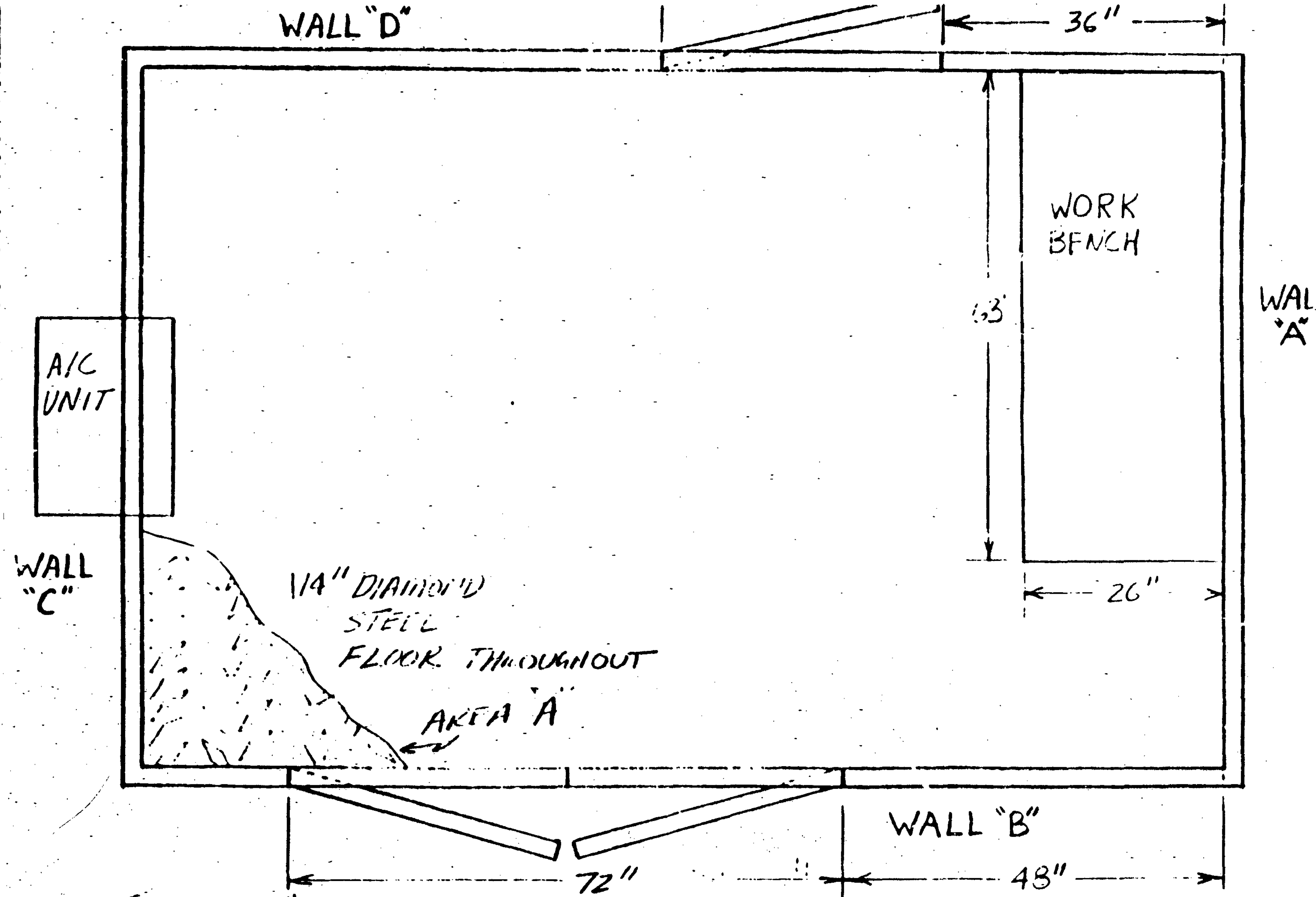
18,000 to 20,000 BTU air conditioner/heat pump to be installed on wall shown on Enclosure 4. Note: AC unit is to be placed up as high as possible on wall.

10. ELECTRICAL:

- All wiring shall be done following the National Electrical Codes.
- All wiring shall be copper and wire size chosen according to amperage requirements of circuit.
- Conduit shall be used to cover all wiring.
- See Enclosure 6, pages 1 and 2 for specific circuir descriptions.
- Gaub entrances shall be 3" threaded PVC pipe and caps. Caps are to be located on the outside of the building structure.

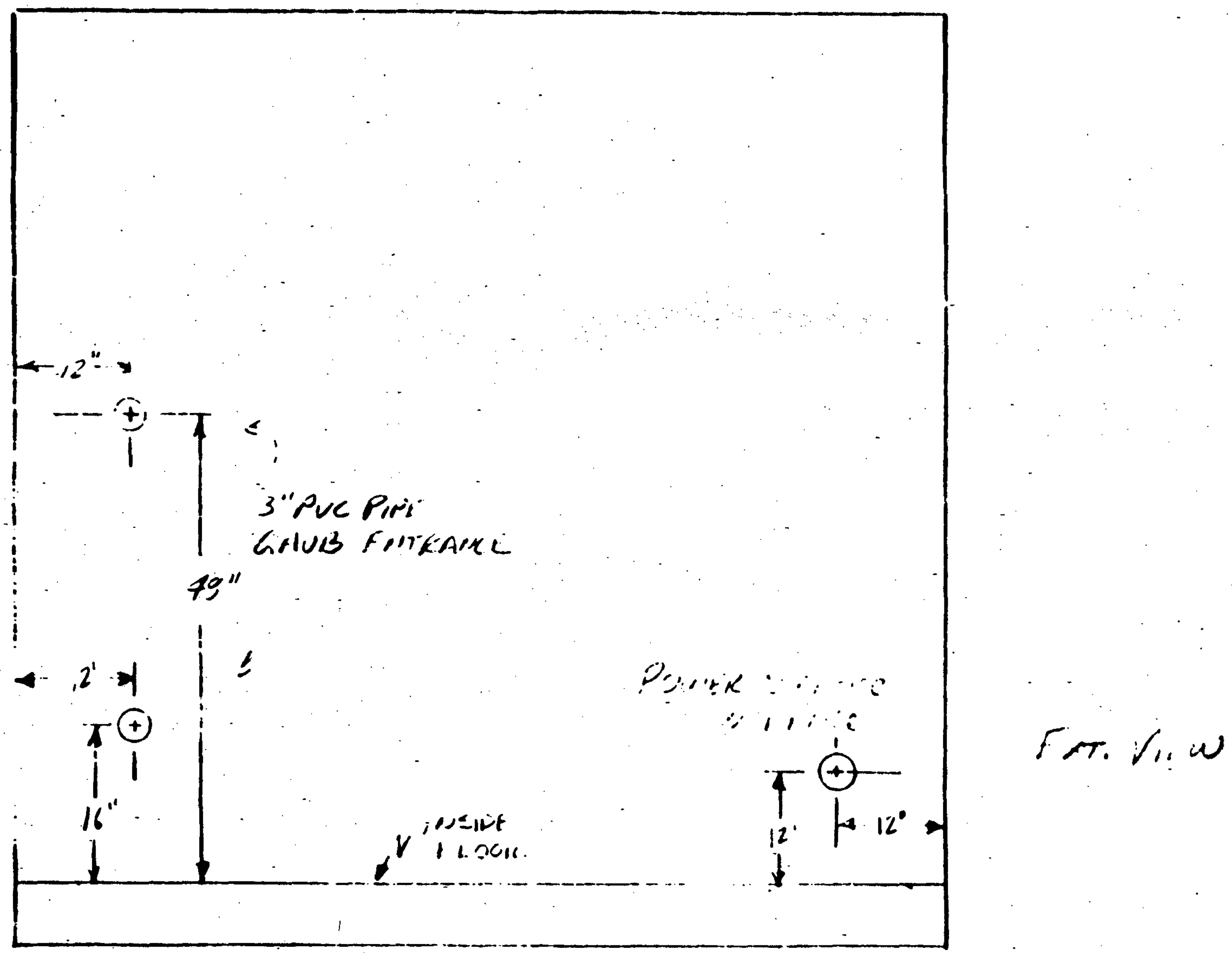
11. ENCLOSURES:

1. Floor plan
2. Wall "A" plan
3. Wall "B" plan
4. Wall "C" plan
5. Wall "D" plan
6. Electrical plan
7. Work bench

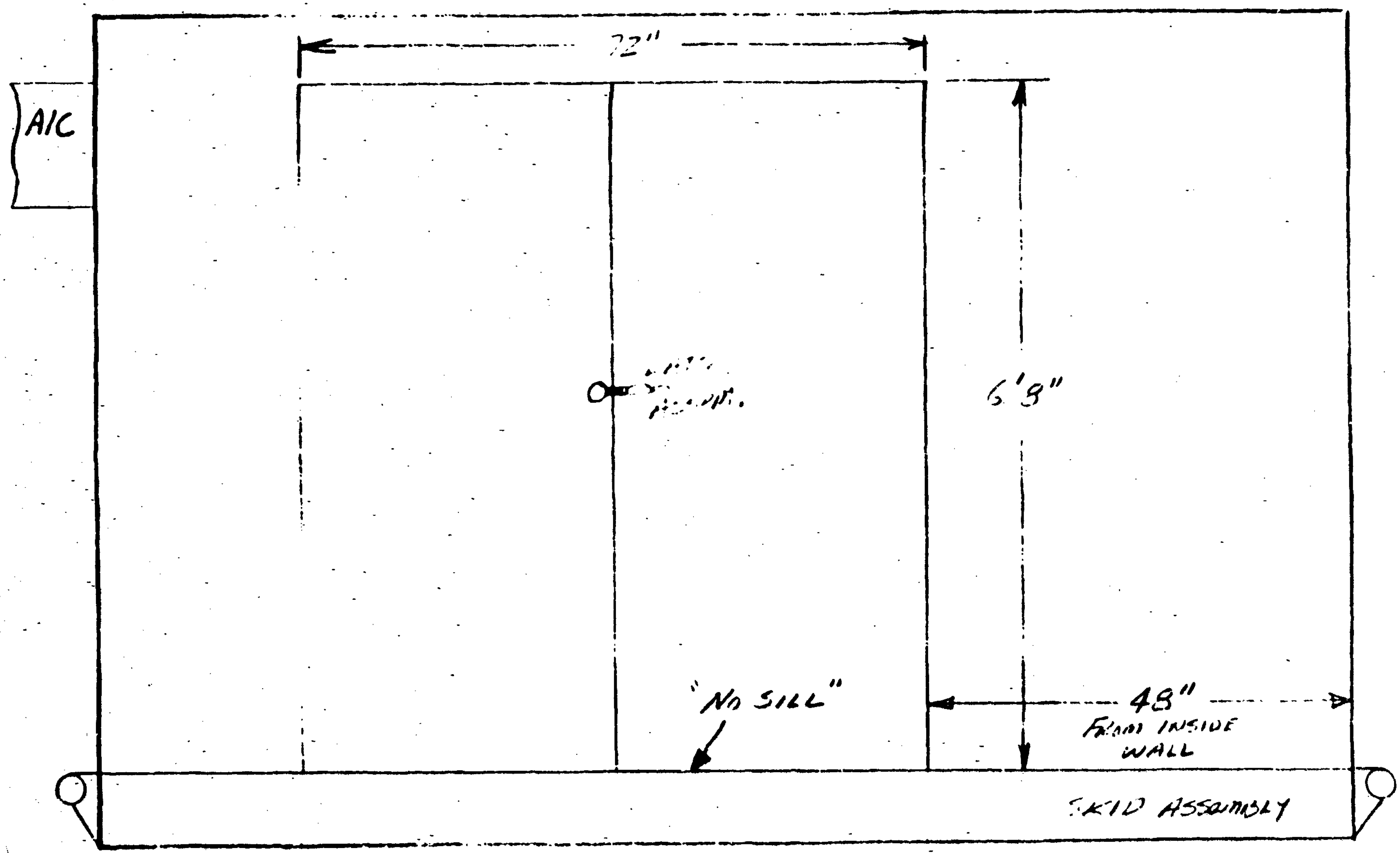


SCALE: 3/4" = 1 FT.

ENCLOSURE 1
FLOOR PLAN

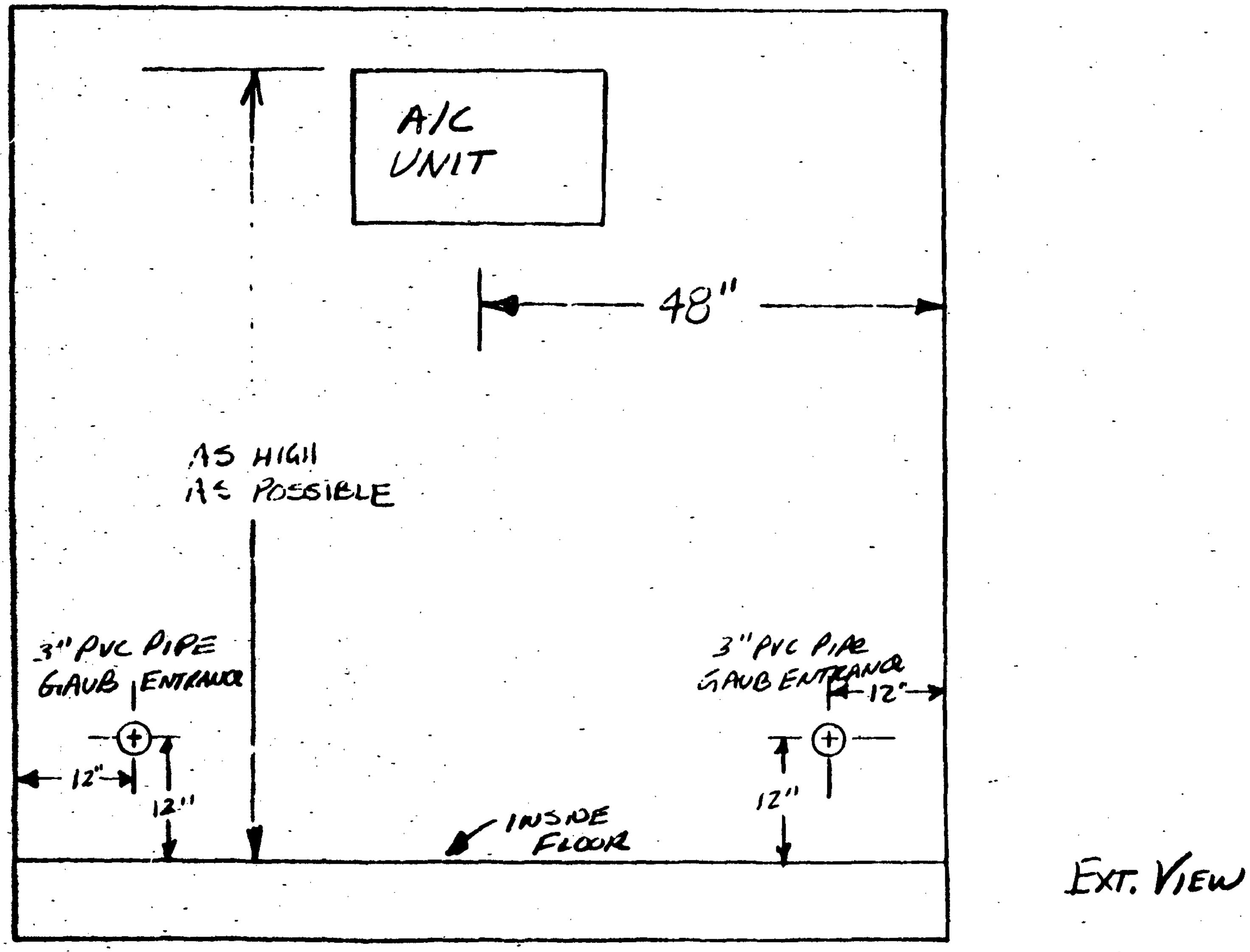


ENCLOSURE Z
WALL "A"
CALE = 1FT

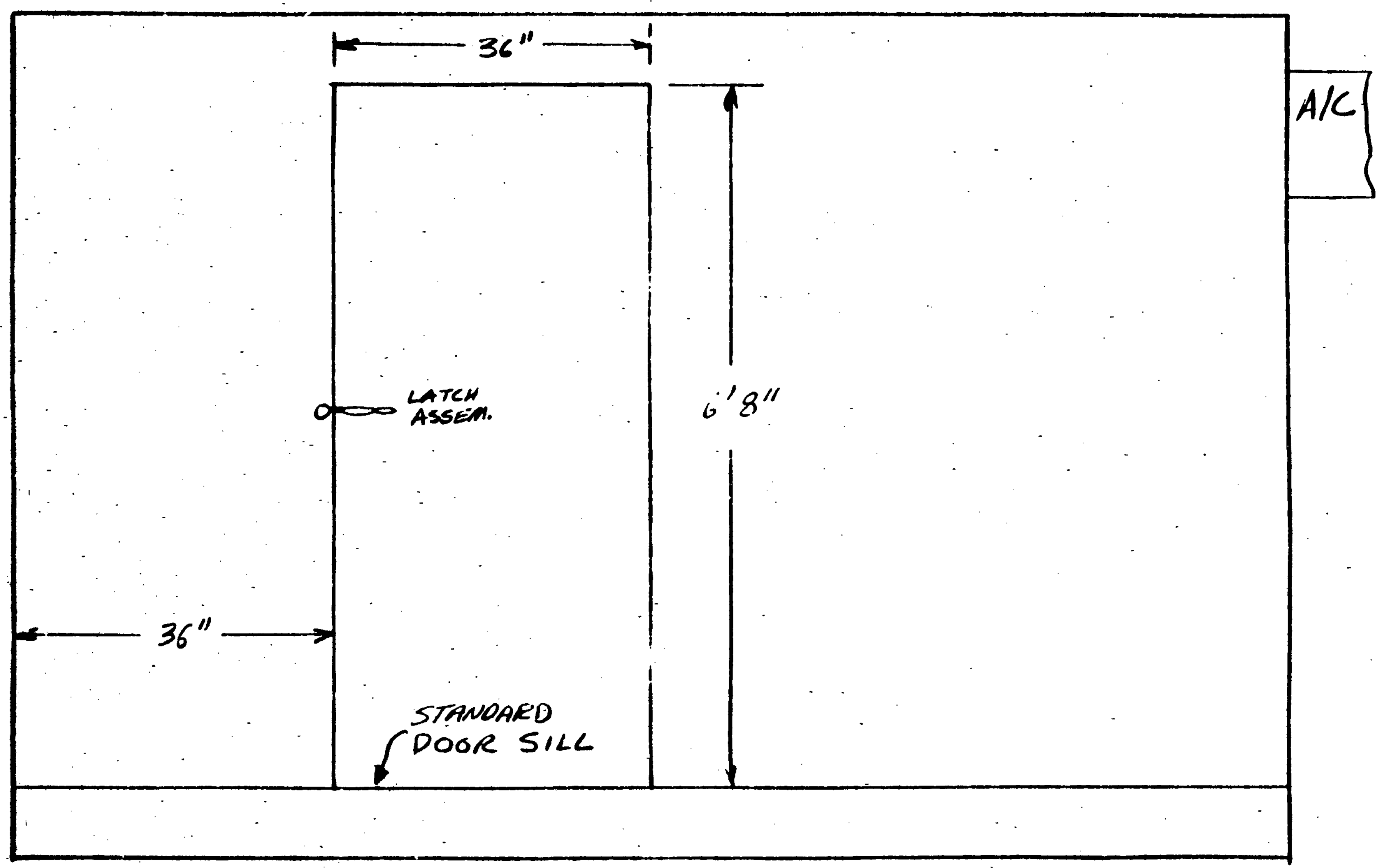


ENCLOSURE 3
WALL "G"
SCALE 3/4" = 1FT

EXT VIEW

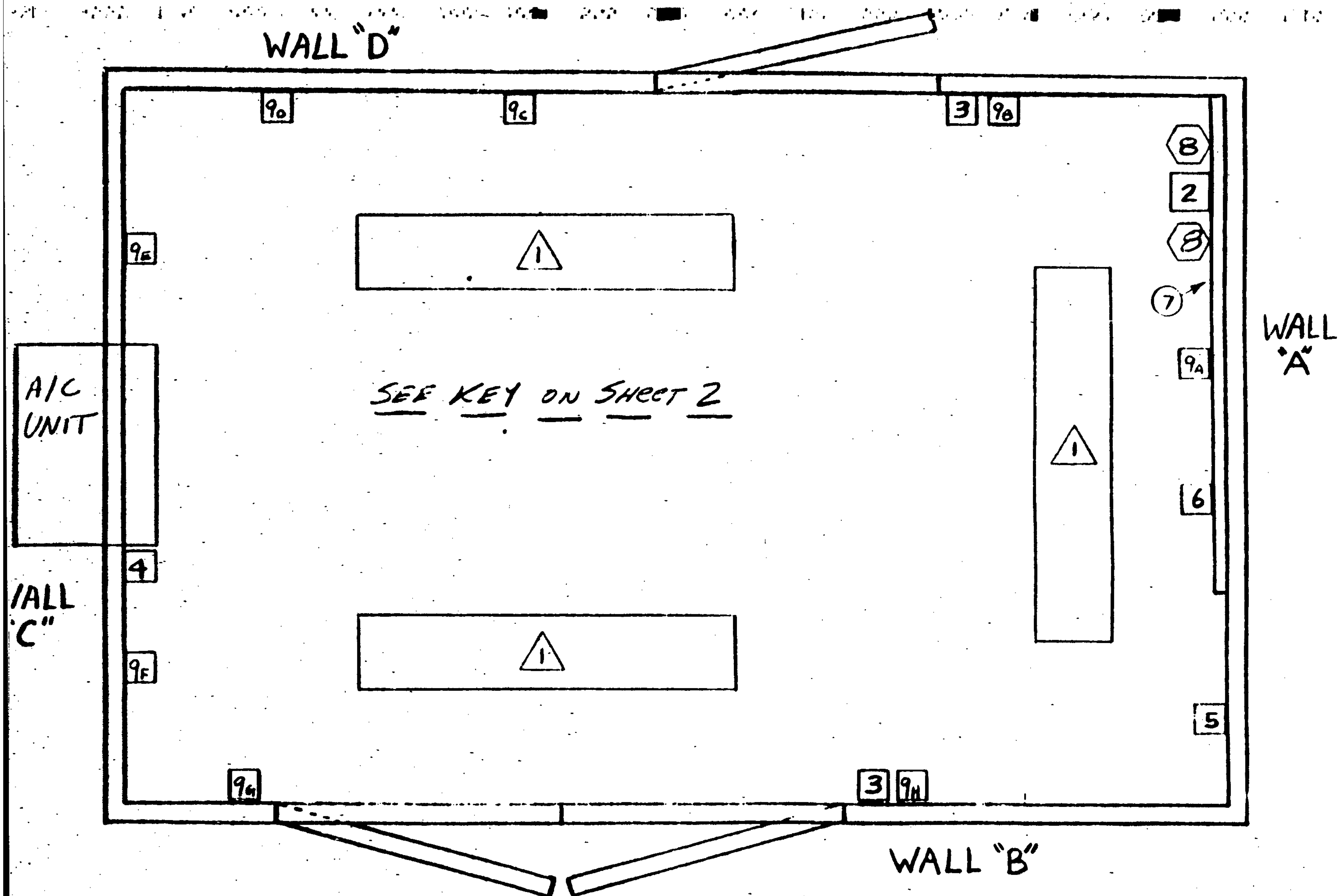


ENCLOSURE 4
WALL "C"
SCALE 3/4" = 1 FT



ENCLOSURE 5
WALL "D"
SCALE 3/4" = 1 FT

EXT. VIEW



SCALE: 3/4" = 1 FT.

ENCLOSURE 6
ELECTRICAL PLAN SHEET 1 OF 2

KEY:

1 = 2-TUBE 40W FLORESCENT FIXTURE

2 = 100A LOAD CENTER POWER DISTRIBUTION PANEL.

3 = 3WAY WALL SWITCHES (FOR LIGHTING ONLY)

4 = 220V 60HZ RECEPTACLE (LOCATED CLOSE TO A/C LOCATION)

5 = 120V 60HZ 20A NEMA TWIST LOCK WALL RECEPTACLE WITH A SEPARATE 20A CIRCUIT BREAKER.

6 = 120V 60HZ 30A NEMA TWIST LOCK WALL RECEPTACLE WITH A SEPARATE 30A CIRCUIT BREAKER.

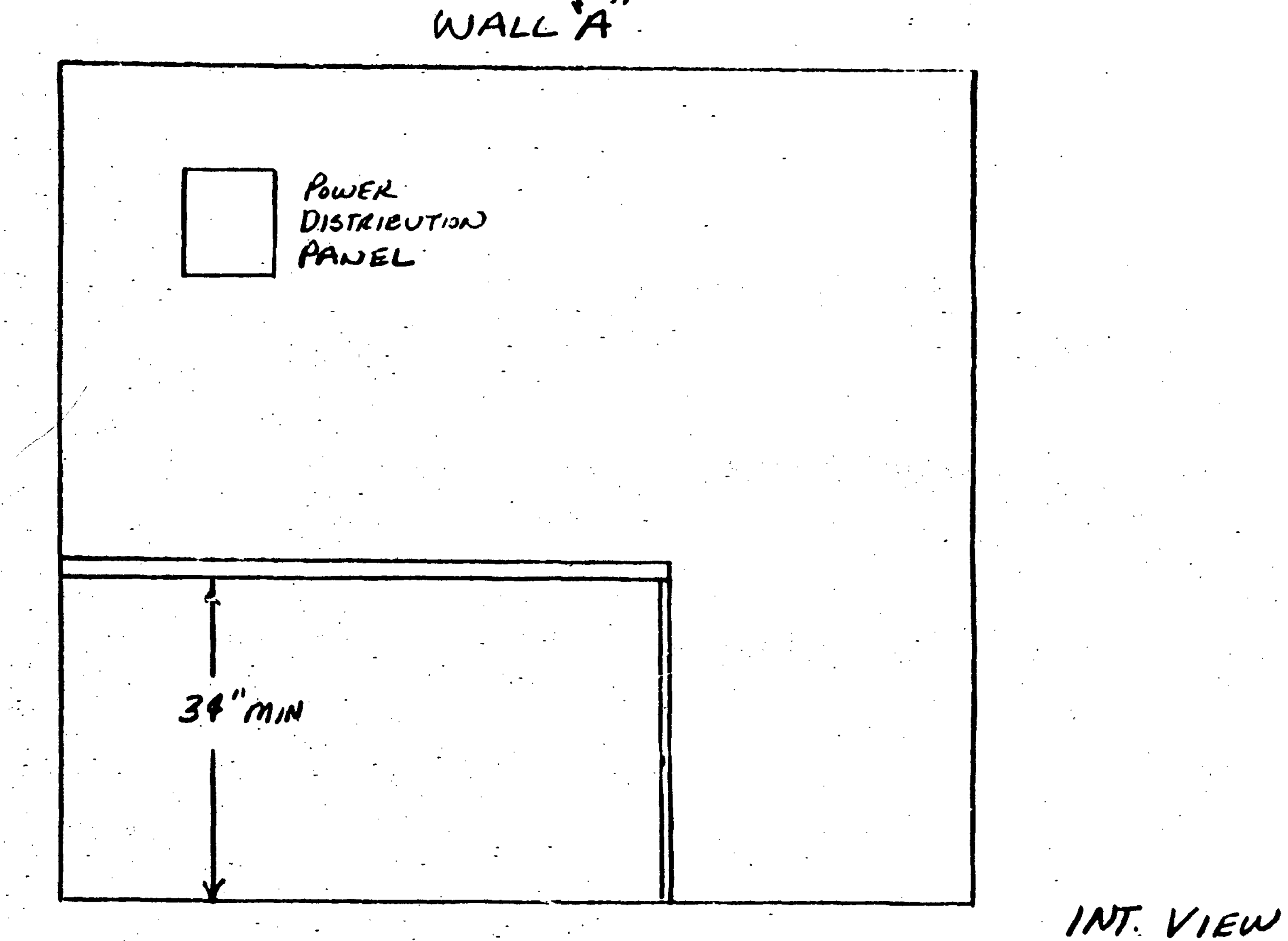
7 = WORKBENCH OUTLET STRIP WITH 15 - 15AMP RECEPTACLES PERMANENTLY MOUNTED ≈ 2" ABOVE WORKBENCH TOP SURFACE.

8 = 2 EACH 6"X6"X2" UTILITY BOXES WITH BLANK COVERS MOUNTED ≈ 16" FROM FLOOR.
- 1 - UTILITY BOX SHALL BE USED FOR THE POWER SERVICE ENTRANCE.
- 1 - UTILITY BOX SHALL BE WIRED DIRECT TO THE MAIN POWER INPUT OF THE POWER DISTRIBUTION PANEL.

9 A-H = 120V 60HZ 20AMP DUPLEX RECEPTACLES. BRANCH CIRCUIT BREAKERS ARE TO BE SELECTED AT THE DISCRETION OF THE MANUFACTURE.

NOTE: ALL RECEPTACLES ARE TO BE LOCATED ≈ 16" FROM THE FLOOR LEVEL EXCEPT AS NOTED.

ENCLOSURE 6 SHEET 2 OF 2



ENCLOSURE 7

WORKBENCH

SCALE 3/4" = 1 FT

APPENDIX D

MSS USER'S MANUAL
23 DECEMBER 1982
REVISION B

1.0 INTRODUCTION

THE MSS USER'S MANUAL IS WRITTEN AS A REFERENCE IN THE USE & OPERATION OF ANY OF THE THREE (3) MICROCOMPUTER SYSTEMS USED DURING MSS SYSTEM TESTING AND/OR DEPLOYMENT: (1.) THE DATA ACQUISITION CONTROLLER [DAC], (2.) THE DATA STORAGE CONTROLLER [DSC], AND THE SHIPBOARD/MOSTEK RECORDING & DIAGNOSTIC SYSTEM [MOSTEK].

THESE THREE (3) SYSTEMS SHARE CERTAIN COMMON COMMANDS & FEATURES, AND DIFFER IN THOSE FUNCTIONS WHICH ARE UNIQUE TO EACH SYSTEMS' INDIVIDUAL HARDWARE CONFIGURATION (E.G., THE D/A CONVERTER ONLY EXISTS IN THE MOSTEK, THEREFORE ONLY THE MOSTEK POSSESSES THE D/A DIAGNOSTIC/TEST FUNCTIONS). THE USER SHOULD FIRST BECOME FAMILIAR WITH THE PURPOSE & CAPABILITY OF A SYSTEM BEFORE ATTEMPTING TO USE ITS SYSTEM CONSOLE. A COPY OF THE 'LINK MAP' FOR A PARTICULAR SYSTEM THE USER NEEDS TO WORK WITH, SHOULD BE EXAMINED FIRST, TO FAMILIARIZE THE USER WITH THOSE ADDRESSES WITHIN SCRATCH RAM WHICH ARE FREE (NO LABELS DEFINED FOR THIS AREA), AND THEREFORE AVAILABLE TO THE USER FOR EXPERIMENTATION, ETC...

EACH COMMAND DOCUMENTED IN THIS MANUAL, IS ACCOMPANIED WITH A LIST OF THE SYSTEMS IN WHICH IT MAY BE FOUND. THOSE COMMANDS WHICH ARE COMMON TO ALL THREE (3) SYSTEMS ARE LISTED AS 'AVAILABLE ON' THE DAC, DSC, & THE MOSTEK. IN ADDITION, THERE ARE SEVRAL SPECIAL PURPOSE COMMANDS & KEYS WHICH ARE DESCRIBED IN THE 'SPECIAL COMMANDS/CONTROL CHARACTERS SECTION'.

2.0 MSS SYSTEM COMMANDS

2.1 SPECIAL COMMANDS/CONTROL CHARACTERS

THERE ARE SIX (6) SPECIAL COMMANDS & KEYS AVAILABLE TO THE USER IN ALL SYSTEMS, TO ALLOW THE USER TO CANCEL COMMANDS, START & STOP SYSTEM CONSOLE DISPLAY, AND RE-TYPE A PREVIOUSLY ENTERED COMMAND FOR A CORRECT FORMAT CHECK.

2.1.1 CONTROL C [^C]

THE 'CONTROL C' [^C] CHARACTER, ENTERED BY STRIKING THE 'CTRL' & 'C' KEYS ON THE KEYBOARD SIMULTANEOUSLY, CAN BE USED TO CANCEL A PARTIALLY ENTERED COMMAND, OR TO TERMINATE SUCH FUNCTIONS AS A 'DISPLAY OF MEMORY'. THE ^C RESETS ALL SYSTEM CONSOLE I/O, BY PURGING ALL COMMAND LINE BUFFERS AND OUTPUTTING A NEW COMMAND PROMPT ON THE SYSTEM CONSOLE ('> ').

2.1.2 CONTROL Q [^Q]

THE 'CONTROL Q' [^Q] CHARACTER, ENTERED BY STRIKING THE 'CTRL' & 'Q' KEYS ON THE KEYBOARD SIMULTANEOUSLY, IS USED TO RESUME SYSTEM CONSOLE OUTPUT, PREVIOUSLY SUSPENDED BY THE '^S' COMMAND.

2.1.3 CONTROL R [^R]

THE 'CONTROL R' [^R] CHARACTER, ENTERED BY STRIKING THE 'CTRL' & 'R' KEYS SIMULTANEOUSLY, RE-ECHOES THE CONTENTS OF THE CURRENT COMMAND LINE BUFFER ON THE SYSTEM CONSOLE. THIS ALLOWS THE USER TO REVIEW A PARTIAL COMMAND WHICH HAS BEEN ENTERED, AND MODIFIED TO THE EXTENT THAT IT IS NOT EASILY RECOGNIZABLE TO THE USER.

2.1.4 CONTROL S [^S]

THE 'CONTROL S' [^S] CHARACTER, ENTERED BY STRIKING THE 'CTRL' & 'S' KEYS SIMULTANEOUSLY, SUSPENDS ALL OUTPUT BY THE SYSTEM TO THE SYSTEM CONSOLE. THIS SYSTEM CONSOLE OUTPUT CAN ONLY BE RE-STARTED BY THE USER ENTERING THE '^Q' CHARACTER.

2.1.5 ESCAPE [ESC]

THE 'ESCAPE' KEY [ESC], CAN BE USED TO TERMINATE THOSE FUNCTIONS WHICH MONITOR THE 'ESCAPE/ABORT FLAG' WITHIN THE 'SYSTEM CONSOLE STATUS BYTE'. CURRENTLY, THE ONLY COMMAND/FUNCTION WHICH RECOGNIZES THE 'ESCAPE' KEY AS ITS TERMINATOR IS THE D/A CONVERTER DATA PLAYBACK UTILITY.

2.1.6 RUBOUT [DEL]

THE 'RUBOUT' OR 'DELETE' KEY [DEL], CAN BE USED TO DELETE THE CHARACTER OR CHARACTERS JUST ENTERED BY THE USER. EACH CHARACTER DELETED IS ECHOED AFTER A '/' CHARACTER ON THE SYSTEM CONSOLE, AND IS SUBSEQUENTLY ELIMINATED FROM THE SYSTEM'S COMMAND LINE BUFFER.

2.2 MSS FUNCTIONAL COMMANDS

AVAILABLE ON:
FFTSYS

THE DISPLAY FFT BIN'S COMMAND ALLOWS THE USER TO DISPLAY ALL OR PART OF A FFT'S. BIN POINTS THE DISPLAY OF PART OF THE FFT'S BINS REQUIRES THAT THE OPERATOR INPUT TWO PARAMETERS WITH THE 'BIN' COMMAND, THE START AND END FFT BIN NUMBER. THIS FUNCTION ASSUMES THAT THE OPERATOR HAS PREVIOUSLY PERFORMED AN FFT, AND THE DATA FROM IT IS STILL PRESENT IN THE FFT SYSTEM'S MEMORY. SHOULD THE OPERATOR ATTEMPT TO DISPLAY A FFT'S BINS BEFORE ANY FFT COMPUTATIONS HAVE BEEN PEFORMED, THE RESULTS WILL BE AS RANDOM AND MEANINGLESS AS THE OPERATOR'S RATIONALE BEHIND SUCH AN ACTION. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
BIN<RET>

  OR

BIN SBIN EBIN<RET>

        WHERE:  SBIN = START FFT BIN NO.
                        [RANGE: 1 TO 1024]
                EBIN = END FFT BIN NO.
                        [RANGE: 1 TO 1024 AND
                         EBIN >= SBIN]
```

EXAMPLE:

```
> BIN 1 256<RET>          ; DISPLAY FFT FROM BIN
                          ; NO. 1 THRU NO. 256
```

AVAILABLE ON:
DAC

THE 'BIP' COMMAMD ALLOWS THE USER TO COMMAND THE BIP IN ONE OF THREE MODES: INITIALIZE [G], SINGLE FREQUENCY CALIBRATION [S], OR FULL FREQUENCY CALIBRATION [F]. IN ADDITION, TWO OTHER PARAMETERS ARE AVAILABLE TO THE USER TO ENABLE THE DISPLAY OF BIP STATUS EACH TIME IT IS RECEIVED [Y], OR TO DISABLE THE DISPLAY OF BIP STATUS [N: DEFAULT CONDITION]. IF A BIP INITIALIZE COMMAND IS ISSUED, AND THE BIP IS SUCCESSFULLY INITIALIZED, A MESSAGE OF "WARNING: BIP INITIALIZED" WILL BE DISPLAYED ON THE DAC SYSTEM CONSOLE. IF EITHER A SINGLE OR FULL FREQUENCY BIP CAL IS REQUESTED, AN ERROR MESSAGE OF "ERROR: BIP CALIBRATION ABORTED" WILL BE OUTPUT ON THE DAC SYSTEM CONSOLE IFF THE CAL COMMANDS ARE NOT PROPERLY ACKNOWLEDGED (USUALLY DUE TO THE ABSENCE OF THE BIP ITSELF). THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
        BIP X<RET>

                WHERE: X = F, FULL FREQUENCY CALIBRATION (USING
                              FIXED FREQUENCY TABLE):
                                14 SEC. OF EDME CAL.
                                        [CAL. STATUS = 11B]
                                72 MIN. OF BIP CAL.
                                        [CAL. STATUS = 10B]
                                60 SEC. OF HA CAL.
                                        [CAL. STATUS = 01B]
                         = G, BIP INITIALIZATION
                         = N, NO BIP STATUS DISPLAY [DEFAULT]
                         = S, SINGLE FREQUENCY CALIBRATION:
                                32 SEC. OF 1 HZ. BIP CAL
                                        (STATUS = 10B)
                                60 SEC. OF HA CAL.    (STATUS =
01B)
                         = Y, BIP STATUS DISPLAY
```

FOR EXAMPLE:

```
        > BIP Y<RET>                ; DISPLAY BIP STATUS
```

...SPLAY MEMORY COMMAND [D]

AVAILABLE ON:
DAC
DSC
MOSTEK
FFTSYS

THE DISPLAY MEMORY COMMAND ALLOWS THE USER TO DISPLAY ANY RANGE OF MEMORY, WHETHER IT BE EPROM OR RAM, ON THE SYSTEM CONSOLE. THE ONLY PARAMETERS REQUIRED ARE THE START & ENDING ADDRESSES (INCLUSIVE) OF THE MEMORY TO BE DISPLAYED. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
D ADDR1 ADDR2<RET>

        WHERE:  ADDR1 = THE START MEMORY DISPLAY ADDRESS
                ADDR2 = THE ENDING MEMORY DISPLAY
                        ADDRESS
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> D 7000 70FF<RET>                ; DISPLAY MEMORY IN THE
                                  ; RANGE 7000H --> 70FFH
```

IMP HCD-75 DATA BLOCK COMMAND [DMP]

AVAILABLE ON:
DSC
MOSTEK

THE DUMP HCD-75 DATA BLOCK COMMAND ALLOWS THE USER TO DISPLAY THE CONTENTS OF ONE OR MORE HCD-75 DATA BLOCKS ON THE SYSTEM CONSOLE, AS THEY ACTUALLY APPEAR ON TAPE. THE FORMAT OF THIS COMMAND IS AS FOLLOWS:

```
DMP TBBB LL<RET>

        WHERE:  TBBB = THE START TRACK/BLOCK #
                       TO BEGIN DUMPING DATA FROM
                LL   = THE NUMBER OF BLOCKS TO
                       BE DUMPED
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

> <u>DMP</u> <u>0000</u> <u>1<RET></u>

C COMMUNICATIONS COMMAND [DSC]

AVAILBLE ON:
DAC

THE DSC COMMUNICATIONS COMMAND ALLOWS THE USER TO ENABLE COMMUNICATIONS THROUGH THE PRIMARY CPU COMMUNICATIONS CHANNEL WITH THE DSC. THIS COMMAND SHOULD ONLY BE USED WHEN NOT IN THE DEPLOYMENT MODE (I.E., BEFORE THE 'GO' COMMAND HAS BEEN ENTERED). ENABLING COMMUNICATIONS WITH THE DSC WILL ALLOW THE DAC TO PASS ALL ACQUIRED DATA (SP-Z,MP-Z,MP-N,MP-E,SP-ZB,SP-N,SP-E) TO THE DSC FOR RECORDING ON THE HCD-75 TAPE DRIVES (THIS COMMAND IS USED WHEN THE 525 BYTE DATA FORMAT IS IN USE). THE USER MUST MAKE SURE THAT A HCD-75 TAPE DRIVE HAS BEEN PROPERLY POWERED-UP IN THE DSC USING THE "PUP" COMMAND BEFORE THE DATA TRANSMISSION TO THE DSC IS INITIATED. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

DSC<RET>

AVAILABLE ON:
DAC
DSC
MOSTEK
FFTSYS

THE EXAMINE MEMORY COMMAND ALLOWS THE USER TO EXAMINE, AND IF DESIRED, MODIFY THE CONTENTS OF ONE OR MORE BYTES OF RAM. THE USER INITIALLY ENTERS AN ADDRESS WHICH IS LOADED INTO THE OPEN MEMORY POINTER. THIS POINTER IS THEN INCREMENTED EACH TIME THE USER MODIFIES A BYTE OF RAM OR STRIKES THE SPACE BAR. THE USER CAN TERMINATE THE EXAMINE MEMORY MODE BY STRIKING THE RETURN <RET> KEY. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
E ADDR1<RET>

          WHERE:  ADDR1 = THE MEMORY ADDRESS TO BEGIN
                          EXAMINING
                    *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> E 7E80<RET>              ; EXAMINE ADDRESS 7E80H
7E80 00 55                 ; MODIFY 7E80H --> 55
7E81 00 SPACE BAR          ; SKIP ADDRESS 7E81
7E82 00 AA                 ; MODIFY 7E82H --> AA
7E83 00 <RET>              ; TERMINATE COMMAND
```

AVAILABLE ON:
DSC

THE POSITION AT END OF TAPE COMMAND ALLOWS THE USER TO POSITION ANY 'POWERED-UP' HCD-75 TAPE TO THE END OF THE PHYSICAL TAPE (I.E., THE FIRST BLOCK OF ANY 'ODD' TRACK). THE POSITIONING OF ALL HCD-75 TAPES IS A PREREQUISITE TO DEPLOYING THE MSS SYSTEM. THE HCD-75 TAPE TO BE POSITIONED AT EOT MUST BE POWERED-UP USING THE "PUP" COMMAND PRIOR TO THE ISSUANCE OF THE "EOT" COMMAND. AFTER THE TAPE HAS BEEN POSITIONED AT EOT, THE CONSOLE PROMPT IS OUTPUT ON THE DSC SYSTEM CONSOLE, AND THE SYSTEM CONSOLE IS THEN AVAILABLE FOR USE (DURING THE EOT TAPE POSITIONING, THE DSC SYSTEM CONSOLE IS UNAVAILABLE TO THE USER). AFTER A TAPE HAS BEEN POSITIONED AT EOT, THE USER MUST ISSUE A 'SYSTEM RESET' TO POWER-DOWN THE HCD-75 TAPE DRIVE. THE FORMAT OF THE EOT COMMAND IS AS FOLLOWS:

EOT<RET>

AVAILABLE ON:
FFTSYS

THE FAST FOURIER TRANSFORM COMMAND PROVIDES THE USER WITH THE CAPABILITY OF COMPUTING A SIMPLE 2K FFT ON ANY DEFINED CHANNEL OF DATA (SP-Z, SP-ZB, SP-N, SP-E, HYDRA-ACOSTIC, MP-Z, MP-N, OR MP-E) WHICH IS RECORDED ON A MSS FORMATTED HCD-75 DATA CARTRIDGE. THE FFT COMMAND REQUIRES THAT THE OPERATOR ENTER THE START TRACK/BLOCK ADDRESS OF THE FIRST MSS FILE TO EXTRACT THE DATA FROM, ALONG WITH THE CHANNEL I.D. NUMBER. THE CHANNEL I.D. NUMBER IS THE SAME AS THOSE USED FOR THE REAL-TIME D/A DISPLAY COMMAND, PLAYBACK D/A DISPLAY COMMAND, ETC... THE FFT COMMAND PROCESSES 2K (2Ø48.) SAMPLES OF THE EDME DATA RECORDED ON THE TAPE. FOR SP CHANNELS AND HYDRA-ACOUSTIC ONLY 1 MSS FILE IS REQUIRED, WHILE THE MP CHANNELS WILL REQUIRE 9 MSS FILES TO EXTRACT ALL 2K SAMPLES (NOTE: FILE LENGTH = 31 BLOCKS). THE FFT WILL BE 'AUTO-NORMALIZED' BASED UPON THE LARGEST FFT BIN POINT FOUND, UNLESS A THIRD PARAMETER IS INCLUDED IN THE FFT COMMAND LINE. IN THIS CASE, THE NORMALIZATION FACTOR CURRENTLY IN MEMORY IS USED, AND WILL CONTINUE TO BE USED UNTIL THE FFT COMMAND IS ALLOWED TO COMPUTE A NEW NORMALIZATION FACTOR BY THE EXCLUSION OF THE THIRD PARAMETER IN THE FFT COMMAND LINE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
FFT TBBB C N<RET>

          WHERE:  TBBB = START MSS FILE TRACK/BLOCK
                          ADDRESS (HEX)
                  C    = CHANNEL NO. I.D. :
                          Ø = SP-Z
                          1 = MP-Z
                          2 = MP-N
                          3 = MP-E
                          4 = HYDRA-ACOUSTIC
                          5 = SP-ZB
                          6 = SP-N
                          7 = SP-E
                  N    = IF PRESENT, NO AUTO-
                          NORMALIZATION WILL OCCUR
```

EXMAPLE:

```
>FFT 2Ø17 1 1<RET>      ; COMPUTE THE FFT FOR MP-Z
                        ; AT TRACK/BLOCK 2Ø17. DON'T
                        ; AUTO-NORMALIZE THE FFT
```

AVAILABLE ON:
DAC
DSC
MOSTEK

THE FILL MEMORY COMMAND ALLOWS THE USER TO FILL A SPECIFIED RANGE OF MEMORY (RAM ONLY) WITH A GIVEN 8-BIT VALUE. THE USER MUST SUPPLY THE START & ENDING ADDRESSES, AND THE 8-BIT 'FILL' VALUE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
F ADDR1 ADDR2 B1<RET>

        WHERE : ADDR1 = THE START MEMORY FILL ADDRESS
                ADDR2 = THE ENDING MEMORY FILL ADDRESS
                B1    = THE 8-BIT FILL VALUE
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> F 7E00 7EFF 00<RET>    ; FILL MEMORY IN THE
                         ; RANGE OF 7E00H --> 7EFFH
                         ; WITH 00H
```

AVAILABLE ON:
DAC

THE INITIATE DEPLOYMENT MODE COMMAND ALLOWS THE USER TO PUT THE DAC IN THE DEPLOYMENT MODE, ENABLING THE FOLLOWING FUNCTIONS WITHIN THE DAC:

(1.) START THE 9 BYTE DATA FORMAT - TIME, DAC STATUS, AND DARS SOH INFORMATION ONLY FOR THE FIRST 4 HOURS
(2.) ENABLE SURFACE COMMUNICATIONS
(3.) ENABLE PRIMARY CPU CHANNEL COMMUNICATIONS WITH THE DSC TO RECORD THE 9 BYTE DATA FORMAT ON TAPE
(4.) ENABLE STORAGE OF HYDRO-ACOUSTIC DATA (16 BITS ONLY)

A SYSTEM RESET, A BIP INITIALIZATION COMMAND ("BIP G<RET>"), AND A TIME INITIALIZATION COMMAND ("TIM DDD HH MM SS<RET>") MUST BE EXECUTED BEFORE INITIATING THE MSS DEPLOYMENT WITH THE "GO" COMMAND ON THE DAC SYSTEM CONSOLE. THE FORMAT OF THE COMMAND IS AS FOLLOWS (, AND REQUIRES NO PARAMETERS)

```
GO<RET>
```

AVAILABLE ON:
DAC

THE INITIATE MOSTEK DEPLOYMENT MODE COMMAND ALLOWS THE USER TO TRANSMIT THE 485 BYTE FORMAT OF THE 1 SECOND DATA BUFFER TO THE MOSTEK FOR EXAMINATION OF THE HYDRO-ACOUSTIC DATA THROUGH THE REAL-TIME D/A CONVERTER DISPLAY UTILITY. THIS COMMAND FUNCTIONS THE SAME WAY AS THE 'INITIATE DEPLOYMENT MODE' COMMAND, WITH THE FOLLOWING TWO EXCEPTIONS:

(1.) ONLY 2 SECONDS OF THE 9 BYTE FORMAT ARE SENT TO THE MOSTEK/SHIPBOARD SYSTEM BEFORE THE 485 BYTE FORMAT IS SENT
(2.) THE SECONDARY CPU COMMUNICATIONS CHANNEL IS ACTIVATED TO COMMUNICATE WITH THE MOSTEK/SHIPBOARD SYSTEM, INSTEAD OF THE DSC

THE FORMAT OF THE COMMAND IS AS FOLLOWS:

GTM<RET>

AVAILABLE ON:
DSC
MOSTEK

THE HCD-75 EXERCISER/DIAGNOSTIC COMMAND ALLOWS THE USER TO EXERCISE UP TO A MAXIMUM OF FOUR (4) HCD-75 TAPE DRIVES, INCLUDING POWER CYCLING, WRITING, AND VERIFYING A TAPE, ALL AT THE USER'S OPTION. THE HCD-75 EXERCISER/DIAGNOSTIC IS COMPLETELY 'MENU' DRIVEN, PROMPTING THE USER FOR EVERY PARAMETER WHICH CONTROLS THE CONFIGURATION OF THE TEST TO BE CONDUCTED ON EACH HCD-75 TAPE DRIVE. A PARTIAL OR FULL TEST CAN BE PERFORMED ON EACH TAPE, DEPENDING UPON THE TYPE OF TEST THE USER SELECTS WHEN PROMPTED. A FULL TEST TYPE SIMPLY MEANS THAT ALL TRACKS & BLOCKS OF A TAPE ARE ACCESSED DURING A FORMAT/WRITE OR VERIFY PASS. WHEN A PARTIAL TYPE OF TEST IS SELECTED, THE USER MUST SPECIFY WHICH TRACKS & BLOCKS ARE TO BE ACCESSED. EACH HCD-75 TAPE DRIVE IS POWER CYCLED AT LEAST ONCE WHEN IT IS POWERED UP FOR THE FIRST TEST. IF MORE THAN ONE TEST IS REQUESTED FOR A PARTICULAR DRIVE, IT IS THE USER'S OPTION AS TO WHETHER OR NOT THE TAPE DRIVE IS POWER CYCLED FOR EACH TEST. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
HCD<RET>
```

FOR EXAMPLE:

```
> HCD                  ; INVOKE HCD-75 EXERCISER/DIAGNOSTIC

DATE [DD-MMM-YY HH:MM] ? 18-MAY-82 12:15<RET>

DSA LOGICAL T/D # [RANGE: 1-20] ? 1<RET>; SELECT
                                        ; LOGICAL TD #1

TYPE OF TEST
[FULL OR PARTIAL] ? P<RET>        ; SELECT A PARTIAL
                                  ; TYPE OF TEST

START TRACK/BLOCK NO. [RANGE: 0000-FFFF] ? 0000<RET>

END TRACK/BLOCK NO. [RANGE: 0000-FFFF] ? 0100<RET>

FORMAT [Y/N] ? Y<RET>             ; FORMAT TAPE

VERIFY [Y/N] ? Y<RET>             ; VERIFY TAPE

NO. OF TESTS THIS DRIVE [RANGE: 1-256] ? 1<RET>

MORE 3M CARTRIDGE DRIVES [Y/N] ? Y<RET>

DSA LOGICAL TD# [RANGE:1-20] ? 2<RET>   ; SELECT
                                        ; LOGICAL TD #2
TYPE OF TEST
```

```
[FULL OR PARTIAL] ? F<RET>        ; SELECT FULL TEST
                                  ; DEFAULT TRACK/BLOCK
                                  ; RANGE OF 0000-FFFF

FORMAT [Y/N] ? Y<RET>    ; FORMAT TAPE

VERIFY [Y/N] ? N<RET>    ; DON'T VERIFY TAPE

NO. OF TESTS THIS DRIVE [RANGE: 1-256] ? 2<RET>

POWER CYCLE DRIVE FOR EACH TEST [Y/N] ? Y<RET>

MORE 3M CARTRIDGE DRIVES [Y/N] ? N<RET>

>
TEST #1
HCD-75 STATUS  0000 0000 0101   TDI # 1   TD # 1   LTD # 1   FT
HCD-75 STATUS  0000 0000 0100   TDI # 1   TD # 1   LTD # 1   VT

TEST #1
HCD-75 STATUS  0000 0000 0000   TDI # 1   TD # 2   LTD # 2   FT
HCD-75 STATUS  0000 0000 FFFF   TDI # 1   TD # 2   LTD # 2   VT

TEST #2
HCD-75 STATUS  0000 0000 0000   TDI # 1   TD # 2   LTD # 2   FT
HCD-75 STATUS  0000 0000 FFFF   TDI # 1   TD # 2   LTD # 2   VT

***** HCD-75 FORMAT/VERIFICATION COMPLETE *****
```

AVAILABLE ON:
MOSTEK

THE READ 1-SECOND DATA BUFFER HEADER COMMAND ALLOWS THE USER TO EXTRACT THE 9-BYTE HEADERS FROM A PRE-RECORDED HCD-75 DATA TAPE, AND DISPLAY ALL HEADERS FOUND ON THE SYSTEM CONSOLE. ALL TIME INFORMATION, DAC STATUS, AND DARS SOH IS DISPLAYED ON THE SYSTEM CONSOLE IN A TABULAR FORMAT. STRIKING THE 'ESCAPE' KEY <ESC> TERMINATES THIS FUNCTION. THE 9-BYTE HEADERS ARE EXTRACTED, BY DEFAULT, FROM THE CURRENTLY SELECTED HCD-75 TAPE DRIVE, WHICH IS DESIGNATED BY THE "PUP" COMMAND (I.E., THE LAST TAPE DRIVE WHICH WAS "PUP'ED"). THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
HDR TBBB<RET>

        WHERE:  TBBB = START TRACK/BLOCK #,
                       IN HEXADECIMAL
```

FOR EXAMPLE:

```
> HDR 0080<RET> ; DISPLAY THE HEADERS OF THE
                ; 1-SECOND DATA BUFFERS
                ; BEGINNING AT TRACK/BLOCK 0080
```

PUT PORT DATA COMMAND [I]

AVAILABLE ON:
DAC
DSC
MOSTEK
FFTSYS

THE INPUT PORT DATA COMMAND ALLOWS THE USER TO INPUT AND EXAMINE DATA FROM ANY DATA PORT IN THE SYSTEM. THE DATA INPUTTED FROM THE SPECIFIED PORT IS DISPLAYED ON THE SYSTEM CONSOLE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
I PP<RET>

        WHERE:  PP = THE 8-BIT INPUT PORT
                     ADDRESS
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> I 5Ø<RET>                 ; INPUT DATA FROM PORT 5ØH
DATA FROM PORT 5Ø = FF      ; DATA INPUTTED FROM
                            ; PORT 5ØH = FFH
```

ST SP DATA COMMAND [LSP]

AVAILABLE ON:
MOSTEK

THE LIST SP DATA COMMAND ALLOWS THE USER TO LIST FOUR (4) CHANNELS OF SHORT PERIOD (SP) DATA ON THE SYSTEM CONSOLE FROM TAPE. THIS UTILITY WILL ONLY EXTRACT SP DATA FROM A 525 BYTE DATA FORMAT TAPE, WHERE SP-ZB IS AVAILABLE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
LSP TBBB LL SS<RET>

        WHERE:  TBBB = START TRACK/BLOCK # OF
                        THE FILE TO EXTRACT SP
                        DATA FROM
                LL   = NO. OF HCD-75 DATA BLOCKS
                        TO READ [RANGE: 1-28]
                SS   = SECOND NO. TO BEGIN
                        EXTRACTING SP DATA FROM
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

> <u>LSP</u> <u>ØØ1F</u> <u>2</u> <u>1<RET></u>

-NI-MISSION SET-UP COMMAND [MINI]

AVAILABLE ON:
DAC
DSC

THE MINI-MISSION COMMAND ALLOWS THE OPERATOR TO CONFIGURE AN ABBREVIATED MISSION ON THE DAC AND DSC, USING ALL 2Ø HCD-75 TAPE DRIVES. A SINGLE PARAMETER IS REQUIRED WITH THIS COMMAND, WHICH REPRESENTS THE NUMBER OF MSS FILES TO BE WRITTEN ON EACH TAPE. IN THIS WAY, THE OPERATOR CAN CONTROL THE DURATION OF A 'MINI-MISSION', KNOWING THAT EACH INCREMENT OF THE PARAMETER, 'N', REPRESENTS APPROXIMATELY 2.8 HOURS. THE EXACT FORMULA FOR CALCULATING THE TOTAL NUMBER OF SECONDS REQUIRED FOR A PARTICULAR MINI-MISSION IS AS FOLLOWS:

TOTAL TIME (SEC.) = (9826 SEC. * N) + 331. SEC.

THE FIRST FILE WRITTEN ON TD #1 WILL BE OF THE 9 BYTE FORMAT, WITH ALL SUBSEQUENT FILES WRITTEN THROUGH TD #1Ø OF THE 485 BYTE FORMAT. THE 245 BYTE FORMAT IS USED IN ALL FILES WRITTEN ON TD'S #11, #12, AND #13, WHILE THE 165 BYTE FORMAT IS USED IN THE FILES WRITTEN ON THE LAST 7 TAPE DRIVES, TD 14 THROUGH TD #2Ø.

THE MINI-MISSION COMMAND SHOULD ONLY BE USED IMMEDIATELY AFTER A SYSTEM RESET, AND MUST BE ENTERED ON BOTH THE DSC & DAC SYSTEM CONSOLES. A MINIMUM OF 3Ø SECONDS SHOULD BE ALLOWED AFTER RESETTING THE DSC BEFORE ENTERING THE 'MINI' COMMAND ON THE DSC SYSTEM CONSOLE. AFTER THE COMMAND HAS BEEN ENTERED FOR BOTH SYSTEMS, THE 'GO' COMMAND CAN BE ENTERED ON THE DAC SYSTEM CONSOLE, WHICH WILL INIITIATE THE TRANSMISSION OF DATA TO THE DSC, FOR STORAGE.

***SPECIAL NOTE: TO USE THE 'MINI' COMMAND IN THE DAC, WHILE RECORDING IN THE SHIPBOARD RECORDING SYSTEM MAY REQUIRE A MODIFICATION AS TO WHERE TO BEGIN RECORDING ON THE TAPE (I.E., AN ALTERNATE START TRACK/BLOCK ADDRESS), IF RECORDING IS TO BEGIN AT A START TRACK/BLOCK ADDRESS OTHER THAN ØØØØH. TO ACCOMPLISH THIS MODIFY THE FOLLOWING MEMORY LOCATIONS IN THE SHIPBOARD RECORDING SYSTEM:

```
5176H <- ALTERNATE START TRACK/BLOCK ADDRESS (LO BYTE)
5177H <- ALTERNATE START TRACK/BLOCK ADDRESS (HI BYTE)

517BH <- ALTERNATE START TRACK/BLOCK ADDRESS (LO BYTE)
517CH <- ALTERNATE START TRACK/BLOCK ADDRESS (HI BYTE)
```

THE FORMAT OF THE 'MINI' COMMAND IS AS FOLLOWS:

```
MINI N<RET>

        WHERE:  N = THE NO. OF MSS FILES TO
```

BE WRITTEN ON EACH TAPE
*** ALL PARAMETERS IN DECIMAL

FOR EXAMPLE:

> MINI 5<RET> ; SET-UP FOR MINI-MISSION OF
; 13 HOURS, 44 MIN., 21 SEC.

AVAILABLE ON:
DAC

THE MOSTEK COMMUNICATIONS COMMAND ALLOWS THE USER TO ESTABLISH COMMUNICATIONS BETWEEN THE DAC AND THE MOSTEK SYSTEM TAHT EMULATES THE DSC FUNCTION OF RECORDING DATA. THIS IS NORMALLY USED WHEN RECORDING THE 525 BYTE DATA FORMAT, AS IS THE CASE WHEN ON-BOARD SHIP PRIOR TO MSS DEPLOYMENT. THE DAC WILL COMMUNICATE WITH THE MOSTEK THROUGH THE SECONDARY CPU COMMUNICATIONS CHANNEL. ONLY ONE OF THE TWO CPU COMMUNICATIONS CHANNELS CAN BE ACTIVE AT ANY GIVEN TIME. THIS COMMAND SHOULD ONLY BE USED PRIOR TO THE INVOCATION OF THE DEPLOYMENT MODE (I.E., BEFORE THE 'GO' COMMAND IS ENTERD BY THE USER ON THE DAC SYSTEM CONSOLE). THE FORMAT OF THE COMMAND IS AS FOLLOWS:

MOS<RET>

AVAILABLE ON:
DAC
DSC
MOSTEK

THE MOVE MEMORY COMMAND ALLOWS THE USER TO MOVE BLOCKS OF MEMORY FROM ONE PART OF THE MEMORY SPACE TO ANY OTHER PART OF MEMORY, PROVIDING THE DESTINATION ADDRESS IS WITHIN RAM. CAUTION SHOULD BE EXERCISED WHEN MANIPULATING ANY PART OF A SYSTEM'S SCRATCH RAM, SINCE THE MAJORITY OF SUCH RAM IN THE DAC & DSC IS USED FOR SYSTEM CRITICAL PURPOSES. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
M ADDR1 ADDR2 ADDR3<RET>

      WHERE:  ADDR1 = THE BEGINNING SOURCE
                      MEMORY ADDRESS
              ADDR2 = THE ENDING SOURCE
                      MEMORY ADDRESS
              ADDR3 = THE BEGINNING DESTINATION
                      MEMORY ADDRESS
              *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> M 7000 7100 7E00<RET> ; MOVE THE BLOCK OF MEMORY
                        ; BETWEEN THE ADDRESSES 7000H
                        ; --> 7100H TO 7E00H
```

AVAILABLE ON:
DAC
DSC
MOSTEK
FFTSYS

THE OUTPUT PORT DATA COMMAND ALLOWS THE USER TO OUTPUT SPECIFIC DATA THROUGH AN 8-BIT PORT, WHOSE ADDRESS THE USER ALSO SPECIFIES. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
O PP DD<RET>

        WHERE:  PP = OUTPUT PORT ADDRESS
                DD = DATA BYTE TO BE OUTPUT
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> O 5Ø 2Ø<RET>  ; OUTPUT A BYTE OF 2ØH TO
                        ; PORT 5ØH

> O 6Ø 1<RET>   ; TURN ON HA CAL.

> O 6Ø Ø<RET>   ; TURN OFF HA CAL.

> O 2Ø 3<RET>   ; TURN OFF

> O 2Ø 7<RET>   ; XTAL COOLER
```

AVAILABLE ON:
FFTSYS

THE FFT PLOT COMMAND ALLOWS THE USER TO PLOT ALL OR PART OF THE FFT PREVIOUSLY COMPUTED BY THE FFT COMMAND. THE FFT PLOT COMMAND ASSUMES THAT THE FFT COMMAND HAS BEEN PREVIOUSLY EXECUTED, AND WILL PLOT MEANINGLESS DATA IF THE OPERATOR HAS NOT HAD THE SENSE TO PERFORM A FFT PRIOR TO REUQESTING A PLOT OF IT. IF A PLOT OF THE ENTIRE FFT IS DESIRED, NO PARAMETERS ARE REQUIRED IN THE COMMAND LINE. OTHERWISE, THE START AND END FFT BIN NUMBERS MUST BE ENTERED. THE FORMAT OF THE FFT PLOT COMMAND IS AS FOLLOWS:

```
PLT<RET>                    ; PLOT ENTIRE FFT

  OR

PLT SBIN EBIN<RET>

        WHERE:  SBIN = START FFT BIN NUMBER
                       [RANGE: 1 TO 1024]
                EBIN = END FFT BIN NUMBER
                       [RANGE: 1 TO 1024, AND
                               EBIN >= SBIN]
                *** ALL PARAMETERS IN DECIMAL.
```

EXAMPLE:

```
PLT 1 256<RET>  ; PLOT THE FFT FROM
                ; BIN'S 1 TO 256
```

AVAILABLE ON:
DSC
MOSTEK
FFTSYS

THE POWER-UP HCD-75 TAPE DRIVE COMMAND ALLOWS THE USER TO MANUALLY POWER-UP AND CONDITION A HCD-75 TAPE DRIVE THROUGH THE USE OF THE SYSTEM CONSOLE. NORMALLY, THE FUNCTION OF POWERING UP A TAPE DRIVE IS UNDERTAKEN BY THE DSC APPLICATIONS PROGRAM, WHEN IT IS ALMOST FOUR (4) HOURS INTO THE MISSION AND THE DBM IS NEARLY FULL. THIS COMMAND MUST BE USED BEFORE ATTEMPTING TO USE ANY TAPE DRIVE AFTER A SYSTEM RESET HAS BEEN EXECUTED. A CONDITIONING DELAY OF APPROXIMATELY 4 1/2 MINUTES IS EXECUTED IN THE 'DSC' BEFORE THE TAPE DRIVE CAN BE ACCESSED FOR ANY PURPOSE. A CONDITIONING DELAY OF 2 1/2 MINUTES, MAXIMUM, IS EXECUTED IN THE 'MOSTEK/SHIPBOARD', WHICH IS NECESSARY TO READ THE 'BAD BLOCK TABLE' FROM THE BEGINNING OF THE TAPE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

PUP TD<RET>

WHERE: TD = THE LOGICAL HCD-75 TAPE DRIVE NO. [RANGE: 1-20]

FOR EXAMPLE:

> PUP 1<RET> ; POWER-UP LOGICAL TAPE DRIVE #1

AVAILABLE ON:
DSC

THE RELAY TEST COMMAND ALLOWS THE USER TO EXERCISE A HCD-75 TAPE DRIVE RELAY A SPECIFIED NUMBER OF TIMES, POWERING IT ON, AND THEN OFF FOR A PERIOD OF 2 SECONDS EACH. THE HCD-75 CONTROLLER/FORMATTER SELECTED WILL BE POWERED ON FOR THE DURATION OF THE RELAY TEST, AND POWERED OFF WHEN IT IS COMPLETED. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
RLT CF TD N<RET>

      WHERE:
             CF = HCD-75 CONTROLLER/FORMATTER NO.
                     [RANGE: 1 OR 2]
             TD = HCD-75 LOGICAL TAPE DRIVE NO.
                     [RANGE: 1 -> 20]
             N  = NO. OF POWER UP/DOWN ITERATIONS TO
                     PERFORM [RANGE: 1 -> 65535]
```

FOR EXAMPLE:

```
> RLT 1 19 20<RET>        ; POWER UP/DOWN HCD-75 TD #19,
                          ; THRU C/F #1, 20 TIMES
```

AVAILABLE ON:
MOSTEK

THE REAL-TIME D/A CONVERTER DISPLAY COMMAND ALLOWS THE USER TO ACTIVATE THE DISPLAY OF A USER SPECIFIED SP OR MP CHANNEL THROUGH THE D/A CONVERTER IN THE MOSTEK SHIPBOARD SYSTEM. THE DATA OF THE CHANNEL SELECTED CAN BE MODIFIED, OR SHIFTED BY A SECOND, OPTIONAL PARAMETER SUPPLIED BY THE OPERATOR. NORMALLY, THE MS 12 BITS (1 SIGN BIT & 11 DATA BITS) ARE OUTPUT TO THE 12 BIT D/A CONVERTER. HOWEVER, IF THE SECOND, OPTIONAL PARAMETER IS SUPPLIED, IT IS USED AS A 'BIT SHIFT RIGHT' COUNTER, WHERE EACH 24-BIT SAMPLE OF DATA IS SHIFTED RIGHT THE SPECIFIED NUMBER OF BITS. AFTER THE SHIFTING, THE RESULTANT 'LOWER' 12 BITS ARE OUTPUT TO THE D/A CONVERTER WITH THE 12TH BIT AS THE SIGN BIT. IF THE 'BIT SHIFT RIGHT' COUNT IS > 12, THEN THE SIGN BIT IS EXTENDED INTO THE UPPER DATA BITS OF THE 12-BIT VALUE OUTPUT TO THE D/A CONVERTER. THE OUTPUT OF THE SP OR MP DATA IS DONE IN REAL TIME (I.E., AT THE ACTUAL SAMPLE RATE: 40 HZ. OR 4 HZ.), AND IS DONE IN LIEU OF RECORDING THE DATA ON TAPE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
RTD C S<RET>

      WHERE:  C = THE SP OR MP CHANNEL DESIGNATOR AS
                  FOLLOWS:
                        0 = SP-Z
                        1 = MP-Z
                        2 = MP-N
                        3 = MP-E
                        4 = HYDRO-ACOUSTIC
                        5 = SP-ZB
                        6 = SP-N
                        7 = SP-E
                = 'END', TERMINATE THE CURRENT
                  REAL-TIME D/A DISPLAY
              S = THE 'BIT SHIFT RIGHT' COUNT
                  [OPTIONAL]
            *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> RTD 0 B<RET>    ; OUTPUT SP-Z DATA THROUGH THE D/A
                  ; CONVERTER, SHIFTING 11 BITS RIGHT
```

AVAILABLE ON:
DAC

THE DISPLAY STATE-OF-HEALTH CHANNEL COMMAND ALLOWS THE USER TO EXAMINE INDIVIDUAL OR ALL DARS AND/OR BIP SOH CHANNELS ON THE SYSTEM CONSOLE. EACH DARS SOH CHANNEL IS UPDATED WITHIN A PERIOD OF < 6 SECONDS, WHILE EACH BIP SOH CHANNEL REQUIRES APPROXIMATELY 32 SECONDS, DEPENDENT UPON CURRENT BIP ACTIVITY. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
SOH N<RET>

          WHERE:  N = DARS SOH CHANNEL NO.
                      [RANGE: 00H - 1FH]
                    = BIP SOH CHANNEL NO.
                      [RANGE: 20H - 3FH]
                      *NOTE: THE BIP SOH CHANNEL NO.
                             ENTERED MUST BE 20H GREATER
                             THAN THE ACTUAL CHANNEL
                                  DESIRED.
                  *** ALL PARAMETERS IN HEXADECIMAL

SOH <RET>

                    = DISPLAY ENTIRE DARS & BIP SOH
                      CHANNEL BUFFER ON THE SYSTEM
                      CONSOLE.
```

FOR EXAMPLE:

```
> SOH 19<RET>       ; DISPLAY THE LATEST HEX DATA FOR
                    ; DARS SOH CHANNEL 19H
SOH CHANNEL NO. 19 - DATA = 009A

> SOH 20<RET>       ; DISPLAY THE LATEST HEX DATA FOR
                    ; BIP SOH CHANNEL 00H
SOH CHANNEL NO. 20 - DATA = 0000
```

AVAILABLE ON:
FFTSYS

THE COMPUTE FFT STANDARD DEVIATION AND MEAN COMMAND ALLOWS THE USER TO COMPUTE THE STANDARD DEVIATION AND MEAN OF ALL OR PART OF THE FFT AS COMPUTED BY THE FFT COMMAND.IF NO PARAMETERS ARE ENTERED IN THE COMMAND LINE, ALL 1024 FFT BIN'S WILL BE USED IN THE COMPUTATION OF THE FFT'S STANDARD DEVIATION AND MEAN. OTHERWISE, TWO PARAMETERS ARE REQUIRED, THE START AND END FFT BIN NUMBERS. THE COMPUTE FFT STANDARD DEVIATION AND MEAN COMMAND ASSUMES THAT THE OPERATOR HAS PREVIOUSLY PERFORMED AN FFT, USING THE FFT COMMAND. IF HOWEVER, THIS WAS NOT DONE, THEN THE OPERATOR WILL GET THE GARBAGE RESULTS DESERVED FOR SUCH A BONEHEAD MISTAKE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
STD<RET>                    ; COMPUTE STANDARD DEVIATION
                            ; AND MEAN FOR ENTIRE FFT

   OR

STD SBIN EBIN<RET>

        WHERE:  SBIN = START FFT BIN NUMBER
                       [RANGE: 1 TO 1024]
                EBIN = END FFT BIN NUMBER
                       [RANGE: 1 TO 1024, AND
                        EBIN >= SBIN]
                *** ALL PARAMETERS IN DECIMAL
```

EXAMPLE:

```
STD 256 1024<RET>           ; COMPUTE THE STANDARD
                            ; DEVIATION AND MEAN FOR FFT
                            ; BIN NUMBERS 256 THRU 1024
```

AVAILABLE ON:
DAC
DSC
MOSTEK
FFTSYS

THE TEST MEMORY COMMAND ALLOWS THE USER TO TEST A SPECIFIED RANGE OF MEMORY, FOR UP TO 256 PASSES ON EACH BYTE OF THE RANGE OF MEMORY. ALL ERRORS ENCOUNTERED ARE REPORTED BY SPECIFYING THE BAD MEMORY BYTE ADDRESS, FOLLOWED BY THE DATA WRITTEN, AND THE DATA READ. THE MEMORY TEST OUTPUTS AN '*' ON THE SYSTEM CONSOLE FOR EACH SUCCESSFUL PASS OF THE ENTIRE MEMORY RANGE. THE TEST MAY BE STOPPED AT ANY TIME BY 'STRIKING' THE <ESC> KEY. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
T BP ADDR1 ADDR2<RET>

        WHERE:  BP    = BOARD/PAGE SELECT (USED ONLY
                        FOR TESTING OF DBM IN THE DSC)
                        [= 00 FOR SCRATCH RAM OR MEMORY
                        IN THE MOSTEK/SHIPBOARD SYSTEM]
                ADDR1 = BEGINNING MEMORY TEST ADDRESS
                ADDR2 = ENDING MEMORY TEST ADDRESS
```

FOR EXAMPLE:

```
> T 00 8000 EFFF<RET>    ; TEST MEMORY RANGE
                         ; 8000 -> EFFF IN THE
                         ; MOSTEK/SHIPBOARD SYSTEM

            *** NOTE: DAC SCRATCH MEMORY RANGE FOR
                         TESTING = 7940 -> 7EFF
                      DSC SCRATCH MEMORY RANGE FOR
            *** NOTE: DBM MEMORY RANGE FOR
                      TESTING == 8000H -> FFFFH
                         TESTING = 7D80 -> 7EFF
                      MOSTEK/SHIPBOARD MEMORY RANGE
                         TESTING = 6000 -> EFFF
```

AVAILABLE ON:
DAC

THE SET REAL-TIME OF DAY COMMAND ALLOWS THE USER TO INITIALIZE/CHANGE THE CURRENT DAY & TIME WITHIN THE DAC SYSTEM, FROM THE SYSTEM CONSOLE. THIS CAPABILITY IS ESPECIALLY USEFUL WHEN SYNCHRONIZING THE DAC WITH WWV. THE JULIAN DAY & TIME OF DAY ARE CONSTANTLY DISPLAYED IN THE UPPER RIGHT-HAND CORNER OF THE DAC SYSTEM CONSOLE. THE FORMAT OF THIS COMMAND IS AS FOLLOWS:

```
TIM DDD HH MM SS<RET>

        WHERE:  MMM = THE JULIAN DAY [RANGE: 1 - 255]
                 HH = HOURS   [RANGE: Ø - 23]
                 MM = MINUTES [RANGE: Ø - 59]
                 SS = SECONDS [RANGE: Ø - 59]
```

FOR EXAMPLE:

```
> TIM 144 1Ø 39 35<RET>
```

D/A CONVERTER DATA PLAYBACK [TXC]

AVAILABLE ON:
MOSTEK

THE D/A CONVERTER DATA PLAYBACK COMMAND ALLOWS THE USER TO EXTRACT DATA FROM A PRE-RECORDED HCD-75 TAPE, AND PLAY IT BACK THROUGH THE 12-BIT D/A CONVERTER. THIS COMMAND HAS THE SAME 'BIT-SHIFT RIGHT' CAPABILITIES AS THE REAL-TIME D/A CONVERTER DISPLAY COMMAND DESCRIBED EARLIER IN THIS MANUAL. THE ONLY DIFFERENCE BEING THE SOURCE OF THE DATA BEING DISPLAYED: THE PLAYBACK COMMAND TAKES ITS DATA FROM TAPE, WHILE THE REAL-TIME D/A DISPLAY ACQUIRED & OUTPUTS DATA IN REAL-TIME. IF THE SP OR MP CHANNEL SPECIFIED BY THE USER DOES NOT EXIST IN THE CURRENT 1-SECOND DATA BUFFER FORMAT ON THE TAPE IN USE, THEN AN APPROPRIATE ERROR MESSAGE IS OUTPUT ON THE SYSTEM CONSOLE, AND NO D/A CONVERTER DISPLAY IS GENERATED. THE DATA TO BE DISPLAYED IS ALWAYS TAKEN FROM THE CURRENTLY SELECTED TAPE DRIVE (I.E., THAT TAPE DRIVE WHICH WAS LAST "PUP'ED"). THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
TXC TBBB C S<RET>

          WHERE:  TBBB = THE TRACK/BLOCK OF THE FILE FROM
                           WHICH DATA IS TO BE EXTRACTED
                       = 'END', TERMINATE THE CURRENT
                           EXECUTION OF THE D/A CONVERTER
                           PLAYBACK
                     C = THE SP OR MP CHANNEL DESIGNATOR
                           AS FOLLOWS:
                                   Ø = SP-Z
                                   1 = MP-Z
                                   2 = MP-N
                                   3 = MP-E
                                   4 = HYDRO-ACOUSTIC
                                   5 = SP-ZB
                                   6 = SP-N
                                   7 = SP-E
                     S = THE 'BIT-SHIFT RIGHT' COUNT
                           [OPTIONAL]

                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> TXC ØØ1F,5,B<RET>        ; OUTPUT SP-ZB DATA, THROUGH THE
                           ; D/A CONVERTER, SHIFTING ALL
                           ; DATA 11 BITS TO THE RIGHT.
```

FFT DATA UPLOAD COMMAND [TXP]

AVAILABLE ON:
MOSTEK

THE FFT DATA UPLOAD COMMAND ALLOWS THE USER TO UPLOAD DATA TO THE VAX 11/780, IN THE PRESCRIBED FORMAT (32-BIT SIGN EXTENDED, REPEAT SAMPLE) FOR FFT ANALYSIS. (***NOTE: THIS COMMAND IS NOT AVAILABLE IN THE SHIPBOARD RECORDING MODE). THE FFT DATA UPLOAD COMMAND MUST BE USED IN CONJUNCTION WITH THE UPLOAD UTILITY ON THE VAX 11/780, NEVER BY ITSELF, SINCE THE UPLOAD OF DATA TO THE VAX, WHEN NOT EXPECTED, CAN GENERATE NUMEROUS ERRORS IN THE VAX. THE USER MUST SELECT THE CHANNEL OF SP OR MP DATA, AND THE NUMBER OF 1K (1024.) BYTE BLOCKS OF DATA TO BE UPLOADED. IF THE SP OR MP CHANNEL DOES NOT EXIST WITHIN THE 1-SECOND DATA BUFFER FORMAT IN USE ON THE TAPE, AN APPROPRIATE ERROR MESSAGE IS OUTPUT TO THE USER ON THE SYSTEM CONSOLE, AND NO UPLOAD IS PERFORMED. THE DATA TO BE UPLOADED IS ALWAYS TAKEN FROM THE CURRENTLY SELECTED TAPE DRIVE (I.E., THAT TAPE DRIVE WHICH WAS LAST "PUP'ED"). THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
TXP TBBB C N<RET>

          WHERE:  TBBB = THE START TRACK/BLOCK ADDRESS
                         OF THE FIRST MSS DATA FILE
                         ON THE HCD-75 TAPE IN USE.
                     C = THE SP OR MP CHANNEL DESIGNATOR
                         AS FOLLOWS:
                                   Ø = SP-Z
                                   1 = MP-Z
                                   2 = MP-N
                                   3 = MP-E
                                   4 = HYDRO-ACOUSTIC
                                   5 = SP-ZB
                                   6 = SP-N
                                   7 = SP-E
                     N = THE NO. OF 1K BYTE BLOCKS OF
                         DATA TO BE UPLOADED.
                *** ALL PARAMETERS IN HEXADECIMAL
```

FOR EXAMPLE:

```
> TXP ØØ1F,4,4   ; UPLOAD 4K BYTES OF HYDRO-
                 ; ACOUSTIC DATA FOR FFT ANALYSIS.
```

UNLOAD HCD-75 TAPE COMMAND [UNL]

AVAILABLE ON:
DSC
MOSTEK
FFTSYS

THE UNLOAD HCD-75 TAPE COMMAND ALLOWS THE USER TO REWIND THE TAPE IN THE 'SELECTED' HCD-75 TAPE DRIVE TO THE EOT (END-OF-TAPE) POSITION, AND ENABLE THE 'UNLOAD LATCH' ON THE FRONT OF THE DRIVE SO THE OPERATOR MAY UNLOAD THE TAPE. THE COMMAND REQUIRES NO PARAMETERS IN THE DSC SINCE ONLY ONE HCD-75 TAPE DRIVE CAN BE 'POWERED-UP AND SELECTED' AT A TIME. WHEN USING THE UNLOAD TAPE COMMAND IN THE MOSTEK/SHIPBOARD SYSTEM, A PARAMETER WHICH SPECIFIES EITHER TD #1 OR TD #2 IS REQUIRED. IN THE MOSTEK/SHIPBOARD SYSTEM, THE USER MUST READY WHICHEVER TAPE DRIVE IS NOT TO BE UNLOADED, BEFORE ATTEMPTING TO UNLOAD A TAPE DRIVE. THE FORMAT OF THE COMMAND IS AS FOLLOWS:

```
UNL TD<RET>

      WHERE:  TD = HCD-75 TAPE DRIVE NO.
                   [RANGE: 1 OR 2]
                   (VALID FOR THE MOSTEK/SHIPBOARD
                    SYSTEM ONLY)
```

FOR EXAMPLE:

```
> UNL<RET>        ; UNLOAD THE SELECTED HCD-75 TAPE

> UNL 1<RET>      ; UNLOAD TD #1 IN THE
                  ; MOSTEK/SHIPBOARD SYSTEM
```

3.Ø HCD-75 ERROR STATUS CODES DESCRIPTION

ALL HCD-75 ERROR MESSAGES DISPLAYED ON THE SYSTEM CONSOLE WILL BE ACCOMPANIED BY AN 'ERROR STATUS CODE' WHICH HELPS TO IDENTIFY WHAT FUNCTION, IN THE APPLICATIONS FIRMWARE, WAS BEING PERFORMED WHEN THE ERROR OCCURRED.

CODE	DEFINITION
CP	C/F POWER CYCLING
DD	HCD-75 DATA DUMPING IN REAL-TIME
FT	HCD-75 FORMATTING TAPE
PD	HCD-75 POWER-DOWN
PU	HCD-75 POWER-UP PHASE
RB	READ BAD BLOCKS ON HCD-75 CARTRIDGE
RR	READ RAM IN C/F (BAD BLOCK TABLE)
TP	TAPE DRIVE POWER CYCLING
TS	ABNORMAL TAPE DRIVE SWITCH
VT	HCD-75 VERIFY TAPE
WB	WRITE BAD BLOCKS ON HCD-75 CARTRIDGE
WR	READ RAM IN C/F (BAD BLOCK TABLE)
**	ABNORMAL STATUS WHEN READING TAPE

GOULD

APPENDIX E

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